RESEARCH REPORT

ASSESSING THE ADEQUACY OF RESIDENTIAL LIGHTING IN TWO CARE CENTRES FOR PERSONS WITH ALZHEIMER'S DISEASE USING THE NEW AGE-ADJUSTED NORTH AMERICAN ILLUMINATION RECOMMENDATIONS

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Assessing the Adequacy of Residential Lighting in Two Care Centres for Persons with Alzheimer's Disease Using the New Age-Adjusted North American Illumination Recommendations

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Abstract

This study extends current knowledge on the design of residential settings for elderly persons by comparing and assessing the suitability of lighting levels in two nearly identical sites for persons with Alzheimer's disease in Edmonton, Alberta. In addition to the centres' lighting levels being contrasted, they were also compared with the new age-adjusted lighting recommendations of the Illuminating Engineering Society of America (IESNA). Goals included determining the effectiveness of the lighting design differences at McConnell Place West (MPW), where lighting was enhanced compared to McConnell Place North (MPN), and to determine if any behavioural differences in the two settings might be attributed to lighting levels. The physical attributes of the two centres (such as differences in colour of walls and floors, etc.) were fully described to investigate how much of the variance between the two centres was attributable to natural daylighting through windows, rather than to light intensity and known characteristics of the artificial illumination. Staff members and family members were asked if they were satisfied with lighting levels, and in addition, residents' utilization of public areas in MPW and MPN was determined through systematic direct observation.

Objective measurement indicated that MPW met the IESNA recommendations in most respects, whereas MPN did not. In many areas, MPW had more than four times the lighting levels found in parallel areas of MPN. Whereas the enhanced lighting in MPW did not dramatically influence the location of resident programs, staff satisfaction with lighting for various activities was in most respects significantly higher at the centre with enhanced lighting. Family members liked the residential-style lighting in both sites. Results indicated that design professionals should consider more carefully the function of each space in order to ensure that appropriate lighting is available for each function. Problems with strong direct sunlight in one centre suggest they also need to provide strategies for controlling light in rooms that receive substantial amounts of such light.

PURPOSE

This study extends current knowledge on the design of residential settings for elderly persons by comparing and assessing the suitability of lighting levels in two nearly identical sites for persons with Alzheimer's disease. The lighting levels, which were designed to be remarkably different in each centre, were also compared with the 1998 age-adjusted recommendations of the Illuminating Engineering Society of America (IESNA). The study also extends current knowledge on the care of persons with Alzheimer's disease by providing information on day-to-day activities in two different lighting conditions.

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Canada Mortgage and Housing Corporation for funding this field study for this very important population. This grant has facilitated research which will add to the knowledge and understanding of lighting as it affects those with dementia, and can be used to improve the quality of life for residents in continuing care centers.

EXECUTIVE SUMMARY

Although scientists have known for decades that aging is associated with dramatic physiological changes in the visual system, there is little applied research on lighting for elderly persons. Researchers have traditionally confined their investigations to the physiology of the aging visual mechanism. Surprisingly, this has influenced the building codes throughout North America. With a dearth of practical studies, the Illuminating Engineering Society of North America (IESNA) based lighting recommendations on studies using young people. Even lighting recommendations purported to be for *aged* persons were based largely on subjects aged 20-30 years. In a few studies, the oldest person was 55. This has had far-reaching effects, because most building codes are based on IESNA lighting recommendations.

Lighting recommendations for those aged 20-30 would not be expected to be appropriate for persons over 60 years. The visual systems of the young and old react very differently. With an identical light source, the retina of a 60-year old receives approximately one-third of the light received by the retina of a 20-year old. Some experts say a 60-year old requires about 2.5 times as much light to see as well as a 20-year old. Although a number of changes in vision occur between the ages of 20 and 40, others such as the thickening and yellowing of the cornea and lens typically occur after age 40. Changes continue as people age.

In 1998, IESNA issued its first age-adjusted lighting recommendations, *Lighting and the Visual Environment for Senior Living*, and acknowledged that previous recommendations were only rough estimates of the actual illuminance needs of the aged. The new recommendations are not based on new research. They represent the consensus of experts, and further revisions will be made. The advice of practitioners working with elderly persons, as well as new field studies, can make a substantial contribution to the development of appropriate lighting standards at this time.

Perhaps the age group 80 years and over is most in need of study. This is the age group typically found in assisted living, retirement, and continuing care settings. Appropriate lighting standards for such settings would benefit both public and private developers interested in renovating or constructing buildings to meet the needs of the growing aging population. Approximately one-quarter of the total population in Canada will be over age 65 by 2031. Although all cohorts of seniors are growing, developing settings for some segments of the population has become a priority. The Canadian Study on Health and Aging (1994) found that 8% of Canadians over the age of 65 and 35% over the age of 85 years suffer from some form of dementia, typically Alzheimer's disease. Approximately half of those with this diagnosis are in facilities that provide oversight and supportive care.

The new IESNA age-adjusted recommendations were not written to cover the needs of special populations like persons with Alzheimer's disease. However, the literature suggests the diminished memory and reasoning capacities of persons with Alzheimer's disease results in these persons being more intensively responsive to the immediate environment than those without cognitive impairment. It is not practical to place them in control of task lighting, so that they can augment ambient light as necessary. The new IESNA document suggests this is an appropriate strategy for the aged. Alzheimer's disease is a neurological condition that results in loss of executive brain function and considerable loss of verbal function; thus they are not good at solving problems such as turning on

more light or finding better light, nor are they apt to verbalize their problem. Thus, the new recommendations may not provide enough information for those who design lighting systems in settings for Alzheimer care. Without field research, the needs of such special populations will not be widely recognized.

The field study reported here examined the suitability and effectiveness of lighting in two remarkably similar residential centres, McConnell Place North (MPN) and McConnell Place West (MPW), operated by *The* Capital Care *Group* in Edmonton, Alberta. They were designed to have remarkably different lighting levels. The centres serve elderly persons with a diagnosis of Alzheimer's disease. Previous light meter readings at one centre indicated lighting levels were low, considering that the average age of residents was over 80 years. Consequently, when the second, nearly identical, centre was constructed the lighting was substantially enhanced. Both centres were built before IESNA published its age-adjusted lighting recommendations; however, their lighting systems were not designed to meet the new recommendations. The lighting met the goals of the clinicians who planned the sites and sought a residential atmosphere. The similarity of the centres and the populations using them presented an unusual opportunity to study the impact of lighting on persons diagnosed with Alzheimer's disease.

The central line of inquiry was whether the lighting levels were suitable for the population and how closely they matched the new IESNA recommendations. The research design used multiple approaches: objective systematic measurement of lighting levels, a survey of staff members' judgment of the lighting levels for various tasks, a parallel survey of residents' family members, and direct real-time observation focusing on the activities and location of residents. In addition, a detailed description was prepared of physical features that may have affected lighting levels. The only remarkable difference found in such features was the obvious one of building orientation. The first centre's (MPN) front door faced north and its back patio south, with the long axis of the building being east-west. The front door of the second centre (MPW) faced east and its back patio west, with the long axis being north-south.

Results show that the second centre with enhanced lighting levels fared far better than the first centre in most comparisons with the new IESNA recommendations. The minimum for ambient light should be 300 lux, [1] according to the new IESNA age-adjusted recommendations. In the three residential wings of each centre, there were remarkable differences. For example, in rooms where residents spent a substantial part of their day, there was from 400 to 600 more lux in the centre with enhanced lighting. At night the differences increased in these rooms, with minimums of 562, 638, and 504 lux in the centre with enhanced lighting, in contrast with minimums of 50, 74 and 71 lux at the other centre. The same pattern of differences was seen in other areas. Task lighting was problematic in many areas of both centres. IESNA recommends 750 lux minimum for reading text, but it was difficult to find an easy chair with that level, day or night. A minimum of 500 lux is recommended for craft and game areas. Tables in the best-used rooms of the centre with enhanced lighting easily met this criterion, but the tables in the same location in other centre was less than recommended, day and night.

[1] Lux is the International System (SI) unit of illuminance. It is the illumination on a surface one square meter in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface, all points of which are at a distance of one meter from a uniform point source of one candela. (IESNA, 1998)

Not surprisingly, staff members at the centre with enhanced lighting were largely satisfied with the lighting conditions, whereas those at the other centre were dissatisfied. Family members expressed concerns only about lighting in residents' bedrooms. Some staff members shared this concern, but they were also concerned about light levels for giving treatments and medications.

Direct observation indicated that the same types of resident programs were conducted in both centres. Therefore, enhanced lighting did not dramatically affect the location where activities were held. Staff, however, organized formal gatherings and selected the locations for them. Casual observations suggested staff rearranged furniture to avoid placing residents where sunlight would strike their eyes, but they were less concerned with furniture located in low light conditions. Informal activities gave a better indication of the areas that residents found pleasing. Residents did not appear to gravitate to well-lit areas for informal activities, such as watching or walking, with the possible exception of the residents in the centre with enhanced lighting who preferred to linger in their well-lit living-dining rooms. Residents typically gathered informally where they could see some activity and interact with each other in small groups. They preferred watching activities in the kitchens of the houses, or watching street traffic. Thus, light did not appear to be a critically important factor in attracting them to an area. The concordance between the location of resident activity and the adequacy of lighting was generally poor. Converging evidence based on systematic observations, staff comments, and casual observations suggested that residents in the centre with poor lighting tended to avoid a hall area with very bright daylight, which had a measured maximum of 31 620 lux. This was the only case where inappropriately bright lighting obviously influenced resident behaviour.

Based on the predominant resident activities in the two centres, the most important areas for residents were locations where they ate, interacted in small groups, and watched television. Appropriate lighting should be available in such areas. The range of activities in which residents have the potential to engage should also be a factor when lighting is selected. In this study, residents engaged in a surprisingly wide range of activities, even without staff guidance. They required appropriate lighting for artistic endeavours, cards, chores (easy housekeeping tasks), cooking, clerical tasks such as writing, games of various sorts, grooming, and reading. Many of these activities required a minimum task lighting of 750 lux according to the new IESNA recommendations. However, that level of task lighting was not available in many of the areas where residents chose to be.

Several issues for design professionals emerged from this study. One was the need to ensure that appropriate task lighting is available. This issue would likely apply to all types of settings for seniors, not just centres where residents have a diagnosis of a dementing disorder. Another design issue that would appear to have general application is the need for design professionals to consider more carefully the function of each space. In this study it was evident that a hall which served as an access to the outdoors, in addition to serving as a passageway, needed to be appropriately lit for both functions; that is, it should have been brighter in daytime and darker at night at the entrance. The hall lighting raised another design issue. The variation in the lighting measurements taken along the length of halls revealed levels that were uneven on both the horizontal and vertical plane. Although such variation is considered relaxing by lighting experts, who recommend non-uniform lighting, this runs against the advice of clinical experts who recommend uniform lighting for persons with Alzheimer's disease. Uniform lighting will appear to be more institutional, and non-uniform lighting more residential, making choices difficult for design professionals. Clinicians should be aware of this potential conflict between the goals of appropriate care and the goals of attractive lighting.

Another issue is the orientation of the building to the sun. The orientation of the centre with enhanced lighting, with its largest bank of windows that faced east and west, did not receive the strong southern light, but appeared to distribute more direct sunlight through the centre than the other centre, where these main windows faced north and south. Orientations that admit light from the south may be preferred for heat and lighting efficiency, but control of strong light needs more consideration by architects and engineers when structures are intended for the aged. The very wide roof overhang at the centre with enhanced lighting was effective in doing this, and appeared to provide a transition area that allowed residents' eyes to adjust to changes in light as they moved between indoors and out. The daylight diagrams in the 1998 IESNA document, *Lighting and the Visual Environment for Senior Living*, illustrate the effectiveness of such strategies.

In conclusion, the enhanced lighting in the one centre may not have dramatically affected resident programs, but it did affect staff satisfaction. Staff members in that centre were very happy with their lighting, whereas staff in the other centre were not. Family members were happy with both centres, with the exception of the lighting in resident bedrooms. This study did not provide any strong evidence that the new IESNA age-adjusted lighting recommendations are appropriate for this study population. Residents appeared to interact with each other, their visitors, and with staff in a wide range of lighting conditions. This does not allow any strong conclusion that all the lighting levels found in the centres are satisfactory for these residents, because residents are not apt to complain or verbalize a problem. One expert suggests inadequate lighting psychologically harms persons with Alzheimer's disease because, unable to avoid problem areas, they may endure daily torment. That was not the case in this study with the extremely bright light found in one area, although it might be true of areas where light was less extreme. Residents appeared to avoid the extreme area, supporting suggestions in the literature that extremely bright light is not appropriate for this population.

Until there is more applied research, Brawley's advice seems apt. She says that lighting provides one of the most important design elements as healthcare settings take on a residential appearance. Lighting design should "increase function, minimize the discomfort and hazards associated with glare, and improve the poor colour rendition of low quality fluorescent light" (Brawley 1997, p. 86). The residential feel of a setting is an important part of the milieu that supports the remaining functions of persons with Alzheimer's disease, and helps maintain their everyday behaviours. Design professionals will require considerable skill to adequately light the residential settings and still maintain a home-like décor. The effort should be worthwhile. There appears to be considerable interest in such residential settings judging by the 200-300 professionals a year who visit the two centres in the study, all of whom have said they are in various planning stages of similar centres.

RÉSUMÉ

Les chercheurs savent depuis des décennies que le vieillissement est associé à des changements physiologiques considérables dans le système visuel, mais peu de recherche appliquée a été faite sur l'éclairage dont les personnes âgées ont besoin. Jusqu'ici, les chercheurs se sont seulement intéressés à la physiologie du mécanisme visuel vieillissant. Étonnamment, cela s'est répercuté sur les codes du bâtiment dans toute l'Amérique du Nord. Étant donné la pénurie d'études pratiques, la Illuminating Engineering Society of North America (IESNA) a fondé ses recommandations visant l'éclairage sur des études faites auprès de jeunes. Même les recommandations d'éclairage s'adressant aux personnes âgées se fondaient en grande partie sur des sujets âgés de 20 à 30 ans. Dans quelques études, le sujet le plus âgé avait 55 ans. Cela a eu d'importantes répercussions étant donné que la plupart des codes du bâtiment se basent sur les recommandations d'éclairage de l'IESNA.

Les recommandations d'éclairage pour les 20 à 30 ans ne conviennent pas aux de plus de 60 ans. Le système visuel des jeunes et des aînés réagit de façon très différente. Face à une source de lumière identique, la rétine d'une personne de 60 ans reçoit environ le tiers de la lumière que reçoit la rétine d'une personne de 20 ans. Selon certains experts, un sexagénaire a besoin d'environ deux fois et demie plus de lumière pour voir aussi bien qu'un jeune de 20 ans. Plusieurs changements dans la vision surviennent entre 20 et 40 ans, mais d'autres comme l'épaississement et le jaunissement de la cornée et du cristallin se produisent généralement après 40 ans. Les changements se poursuivent au fur et à mesure que l'on avance en âge.

En 1998, l'IESNA a émis ses premières recommandations d'éclairage ajustées en fonction de l'âge intitulées *Lighting and the Visual Environment for Senior Living* en reconnaissant que ses recommandations précédentes ne représentaient qu'une estimation approximative des besoins d'éclairage des aînés. Les nouvelles recommandations ne reposent pas sur des recherches nouvelles. Elles correspondent au consensus des experts et feront l'objet de nouvelles révisions. L'avis des praticiens qui travaillent auprès des aînés de même que les nouvelles études pratiques peuvent largement contribuer à l'élaboration de normes d'éclairage appropriées.

Le groupe âgé de 80 ans et plus est sans doute celui qui a le plus besoin d'être étudié. Il s'agit des personnes qui résident généralement dans les logements pour les aînés, les maisons de retraite et les foyers de soins. Des normes d'éclairage appropriées seraient utiles aux promoteurs publics et privés désireux de rénover ou de construire des bâtiments répondant aux besoins d'une population vieillissante. Environ le quart de la population totale du Canada sera âgée de plus de 65 ans d'ici 2031. Toutes les cohortes d'aînés augmentent, mais il est devenu prioritaire d'établir des normes pour certains segments de la population. L'Étude sur la santé et le vieillissement au Canada (1994) a révélé que 8 % des Canadiens âgés de plus de 65 ans et 35 % de ceux qui avaient plus de 85 ans souffraient d'une certaine forme de démence, généralement de la maladie d'Alzheimer. Environ la moitié de ces personnes vivent dans des établissements qui leur fournissent une supervision et des soins.

Les nouvelles recommandations de l'IESNA ne visait pas à répondre aux besoins de groupes particuliers comme les personnes souffrant de la maladie d'Alzheimer. Cependant, les publications

sur le sujet laissent entendre qu'en raison de la diminution de leur mémoire et de leur capacité de raisonnement, les personnes atteintes de la maladie d'Alzheimer répondent de façon plus intense à leur environnement immédiat que celles qui n'ont pas de handicaps cognitifs. Il n'est pas vraiment possible de les laisser contrôler leur éclairage direct afin qu'elles puissent augmenter son intensité selon leurs besoins. Le nouveau document de l'IESNA laisse pourtant entendre que c'est la stratégie qui convient pour les aînés. La maladie d'Alzheimer est un état neurologique qui entraîne une perte des fonctions cognitives et verbales si bien que les personnes qui en souffrent ne sont pas en mesure d'augmenter l'intensité de l'éclairage, de se déplacer vers une meilleure source de lumière ou d'exprimer verbalement leurs difficultés. Par conséquent, les nouvelles recommandations ne fournissent peut-être pas assez de renseignements pour ceux qui conçoivent les systèmes d'éclairage dans les établissements destinés aux personnes atteintes de la maladie d'Alzheimer. En l'absence de recherches sur le sujet, on ne tiendra pas suffisamment compte des besoins de ces personnes.

L'étude de terrain qui fait l'objet du présent rapport porte sur l'efficacité de l'éclairage dans deux centres résidentiels très semblables, McConnell Place North (MPN) et McConnell Place West (MPW), exploités par *The Capital Care Group*, à Edmonton, en Alberta. Le niveau d'éclairage de ces deux établissements est très différent. Ces centres desservent des personnes âgées atteintes de la maladie d'Alzheimer. Le niveau d'éclairage mesuré dans le premier de ces centres était bas compte tenu du fait que l'âge moyen des résidents était de plus de 80 ans. Par conséquent, lorsque le deuxième centre, presque identique, a été construit on y a largement amélioré l'éclairage. Les deux centres ont été bâtis avant que l'IESNA ne publie ses recommandations d'éclairage ajustées en fonction de l'âge. Leurs systèmes d'éclairage n'ont pas été conçus de façon à répondre aux nouvelles recommandations. Ils répondent plutôt aux objectifs des cliniciens qui ont planifié le projet et qui recherchaient une atmosphère résidentielle. La similarité des deux centres et de leur clientèle offrait une occasion exceptionnelle d'étudier les répercussions de l'éclairage sur les personnes atteintes de la maladie d'Alzheimer.

L'étude visait avant tout à établir si les niveaux d'éclairage convenaient aux résidents de ces deux centres et dans quelle mesure ils satisfaisaient aux nouvelles recommandations de l'IESNA. Les charcheurs ont utilisé des approches multiples : une mesure systématique objective aux niveaux d'éclairage, une évaluation, par les membres du personnel, des niveaux d'éclairage disponibles pour diverses tâches; une évaluation parallèle par les membres de la famille des résidents et une observation directe en temps réel des activités des résidents et des lieux où elles se situaient. De plus, les chercheurs ont préparé une description détaillée des caractéristiques physiques qui peuvent avoir influé sur les niveaux d'éclairage. La seule différence digne de mention constatée est l'orientation des bâtiments. Dans le premier centre (MPN), la porte d'entrée est orientée au nord et la cour arrière au sud, l'immeuble étant disposé sur un axe est-ouest. Le deuxième centre (MPW) a sa porte d'entrée à l'est, sa cour arrière à l'Ouest et est disposé sur un axe nord-sud.

Les résultats montrent que le deuxième centre, qui bénéficie d'un meilleur éclairage, s'aligne beaucoup mieux que le premier sur les nouvelles recommandations de l'IESNA. Le minimum pour l'éclairage ambiant devrait être de 300 lux[1] selon les nouvelles recommandations de l'IESNA

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[1] Le lux est l'unité d'intensité lumineuse du Système international (SI), équivalent à l'éclairement d'une surface qui reçoit d'une manière uniformément répartie, un flux lumineux de 1 lumen par mètre carré ou l'éclairement

ajustées en fonction de l'âge. Dans les trois ailes résidentielles de chaque centre, d'importantes différences ont été constatées. Par exemple, dans les pièces où les résidents passent une bonne partie de leur journée, il y avait de 400 à 600 lux de plus dans le deuxième centre. Le soir, l'écart augmentait, l'éclairage minimum étant de 562, 638 et 504 lux dans le centre le mieux éclairé contre des minimums de 50, 74 et 71 lux dans l'autre centre. Les mêmes différences ont été constatées dans d'autres secteurs. L'éclairage direct était déficient dans de nombreuses zones des deux centres. L'IESNA recommande un minimum de 750 lux pour la lecture, mais il était difficile de trouver un fauteuil disposant de ce niveau d'éclairage, le jour ou la nuit. Un minimum de 500 lux est recommandé pour les travaux d'artisanat et les jeux. Les tables des pièces les plus utilisées du centre le mieux éclairé répondaient facilement à cette norme, mais celles de l'autre centre ne respectaient pas les recommandations, tant le jour que la nuit.

Il n'est pas étonnant que les membres du personnel du centre le mieux éclairé étaient largement satisfaits de l'éclairage tandis que ceux de l'autre centre en étaient mécontents. Les membres de la famille ont seulement exprimé des préoccupations au sujet de l'éclairage des chambres des résidents. Certains membres du personnel partageaient leurs inquiétudes, mais ils se préoccupaient également du niveau d'éclairage dont ils disposaient pour dispenser des soins et des médicaments.

L'observation directe a révélé que les deux centres offraient le même genre de programmes à leurs résidents. Par conséquent, l'amélioration de l'éclairage n'avait pas d'énormes répercussions sur l'endroit où avaient lieu ces activités. Néanmoins, le personnel organisait les réunions et en choisissaient le lieu. L'observation a révélé que le personnel déplaçait le mobilier pour éviter que les résidents n'aient le soleil en plein dans les yeux, mais qu'ils se souciaient moins des meubles situés dans les zones peu éclairées. Les activités informelles donnaient une meilleure idée des zones où les résidents trouvaient agréable d'aller. Les résidents ne semblaient pas rechercher les zones bien éclairées pour les activités informelles, par exemple pour regarder ou pour marcher, si ce n'est que les résidents du centre bénéficiant d'un meilleur éclairage préféraient s'attarder dans leur salle-à-manger bien éclairée. En général, les résidents recherchaient les endroits où ils constataient une certaine activité et où ils pouvaient interagir en petits groupes. Ils préféraient regarder ce qui se passait dans les cuisines ou dans la rue. Par conséquent, l'éclairage ne semblait pas être un facteur extrêmement important pour les attirer vers une zone. Le rapport entre les lieux d'activité et l'éclairage était généralement faible. Un ensemble de preuves constituées d'observations systématiques, des commentaires du personnel et d'observations occasionnelles indiquait que les résidents du centre le moins bien éclairé avaient tendance à éviter un hall fortement éclairé par la lumière du jour dont l'intensité maximum a été mesurée à 31 620 lux. C'est le seul cas où une trop grande luminosité influençait de façon évidente le comportement des résidents.

D'après l'observation des principales activités dans les deux centres, les endroits les plus importants pour les résidents étaient les pièces où ils mangeaient, où ils interagissaient en petits groupes et où ils regardaient la télévision. Ces secteurs devraient disposer d'un éclairage adéquat. La gamme d'activités à laquelle les résidents peuvent se livrer devrait également être prise en considération pour le choix de l'éclairage. L'étude a révélé que les résidents se livraient à une

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d'une surface dont tous les points sont à un mètre de distance d'une source uniforme de lumière d'une candela. (IESNA, 1998)

gamme étonnamment vaste d'activités, même sans être guidés par le personnel. Ils avaient besoin d'un éclairage adéquat pour faire des travaux d'artisanat, jouer aux cartes, accomplir des petites tâches ménagères, cuisiner, écrire, participer à divers jeux, faire leur toilette et lire. Un grand nombre de ces activités exigent un éclairage minimum de 750 lux selon les nouvelles recommandations de l'IESNA. Cependant, ce niveau d'éclairage n'était pas disponible dans la plupart des zones où les résidents choisissaient d'aller.

Cette étude soulève plusieurs questions pour les professionnels chargés de concevoir ce type d'établissement. Il s'agit d'abord d'assurer un éclairage adéquat pour les diverses tâches. Cela vaut sans doute pour tous les types d'établissements destinés aux personnes âgées et pas seulement pour les centres pour personnes atteintes de démence. Une autre conclusion d'application générale est la nécessité de tenir mieux compte de la fonction de chaque espace. Il ressortait nettement de cette étude qu'un hall qui servait à la fois d'accès à l'extérieur et de couloir devait être éclairé pour ces deux fonctions, c'est-à-dire mieux éclairé le jour que la nuit. L'éclairage du hall soulevait également un autre problème de conception. La variation dans les mesures d'éclairage prises le long des couloirs a relevé des niveaux inégaux tant à l'horizontale qu'à la verticale. Les experts en éclairage considèrent que ces variations sont reposantes et recommandent un éclairage non uniforme, mais cela va à l'encontre de l'avis des experts cliniques qui recommandent un éclairage uniforme pour les personnes atteintes de la maladie d'Alzheimer. Un éclairage uniforme semble plus institutionnel tandis qu'un éclairage non uniforme apparaît plus résidentiel, ce qui rend le choix difficile pour les concepteurs. Les cliniciens devraient être conscients de ce conflit potentiel entre les objectifs centrés sur les soins et les objectifs centrés sur un éclairage attrayant.

L'orientation de l'immeuble soulève également un problème. Le centre le mieux éclairé, dont les principales fenêtres faisaient face à l'est et à l'ouest, ne recevait pas de la forte lumière du sud, mais il semblait bénéficier d'un ensoleillement plus direct que le premier centre dont les principales fenêtres étaient orientées au nord et au sud. Une orientation plein sud peut être jugée préférable pour la chaleur et l'éclairage, mais les architectes et les ingénieurs doivent chercher davantage à contrôler la luminosité lorsqu'un immeuble est destiné aux personnes âgées. La toiture largement en surplomb du centre le mieux éclairé jouait bien son rôle à cet égard en fournissait une zone de transition qui permettait aux yeux des résidents de s'adapter aux changements de luminosité entre l'intérieur et l'extérieur. Les diagrammes concernant l'éclairage de jour du document de l'IESNA, *Lighting and the Visual Environment for Senior Living*, publié en 1998, illustre l'efficacité de ce genre de stratégies.

Pour conclure, l'éclairage amélioré du deuxième centre n'a peut-être pas eu d'importantes répercussions sur les programmes offerts aux résidents, mais il a eu une influence sur la satisfaction du personnel. Les membres du personnel de ce centre étaient très satisfaits de leur éclairage tandis que ceux du premier centre ne l'étaient pas. Les membres des familles étaient satisfaits de l'éclairage des deux centres sauf pour les chambres des résidents. L'étude présentée ici n'a pas vraiment démontré que les nouvelles recommandations d'éclairage de l'IESNA ajustées en fonction de l'âge conviennent à la population sur laquelle elle portait. Les résidents semblaient interagir les uns avec les autres, avec leurs visiteurs et le personnel dans diverses conditions d'éclairage. Cette constatation ne permet pas de conclure que tous les niveaux d'éclairage trouvés

dans ces centres étaient satisfaisants pour les résidents étant donné que ces derniers n'étaient pas en mesure de se plaindre ou d'exprimer verbalement leurs difficultés. Un expert estime qu'un éclairage inadéquat cause un tort psychologique aux personnes souffrant de la maladie d'Alzheimer, car du fait qu'elles ne peuvent pas éviter les zones où elles ont des difficultés, elles risquent d'en éprouver quotidiennement. Ce n'est pas ce qui a été constaté dans le cadre de cette étude pour ce qui est de la zone à l'éclairage très vif observée dans un des centres, mais cela pourrait être vrai pour les secteurs moins bien éclairés. Les résidents semblaient éviter les zones où l'éclairage était excessif, ce qui confirme les études selon lesquelles un éclairage extrêmement lumineux ne convient pas à ces personnes.

Tant qu'on n'aura pas effectué davantage de recherche appliquée, le conseil de Brawley semble justifié. Elle déclare que l'éclairage est l'un des éléments les plus importants de la construction des immeubles lorsque les établissements de soins de santé prennent une allure résidentielle. La conception de l'éclairage devrait « augmenter la fonction, réduire l'inconfort et les risques associés à l'éblouissement et améliorer leurs couleurs mal rendues par un éclairage fluorescent de mauvaise qualité» (Brawley, 1997, p. 86). L'atmosphère résidentielle d'un établissement est un élément important du milieu qui soutient les fonctions restantes des personnes atteintes de la maladie d'Alzheimer et qui les aide à préserver leur comportement quotidien. Les concepteurs ont besoin de grandes compétences pour éclairer adéquatement l'établissement tout en préservant un décor similaire à celui d'une résidence privée. Il vaut la peine de déployer des efforts à cet égard. Ce genre de cadre résidentiel semble susciter énormément d'intérêt étant donné que les 200 à 300 professionnels qui visitent chaque année les deux centres sur lesquels l'étude portait ont tous déclaré qu'ils en étaient à divers stades de la planification de centres similaires.

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CHAPTER 1 - PROBLEMS WITH LIGHTING IN ADVANCED AGE

For several decades, design professionals working with the aged have said that long-accepted lighting standards were inappropriate for settings where elderly persons live (Brawley 1977; Noell 1992). The Illuminating Engineering Society of North America (IESNA) was in the best position to initiate changes. The society's standards were integral to lighting standards set by federal, state and provincial governments (Brawley 1997). IESNA took a first step in 1998 by releasing a draft version of the first age-adjusted industry lighting "standards," which it terms recommendations, and confirming the inadequacy of its previous standards for seniors. The earlier standards were developed using subjects aged 20-30 (IESNA 1998), and when revisions were made, they were based on 55-year-olds (Noell 1992). This resulted in recommendations now acknowledged to be only rough estimates of the actual lighting needs of elderly persons.

Noell, who chaired the IESNA committee that prepared the new age-adjusted recommendations, has said that design professionals have a big challenge as they attempt to understand appropriate lighting for the aged, "it is important to understand where we have been, which is on the wrong track" (Noell 1992, p. 67, 68). The new IESNA document uses a different approach than previous standards, focusing on quality issues such as luminance, glare, colour, and reflectance. The authors provide advice on design and other goals, for example, to make seniors' living spaces residential. The new document contains only minimum illuminance levels for ambient light and task lighting, with the warning that task light levels are "absolute minimums."

The previous recommendations for elderly persons essentially said that designers should provide higher levels of illuminance for persons over age 40. Although this was a valid recommendation because older eyes typically need more lighting to increase the visibility of objects, it was considered far from adequate (Brawley 1977; Noell 1992). However, good applied research on vision was not always available. Even now the new IESNA age-adjusted recommendations say that virtually all current data on visibility levels are based on young eyes. The same was true a decade ago when Horowitz reviewed studies on vision and aging for The Gerontological Society of America. She said the literature on "vision and aging neither adequately nor systematically addresses the complex biopsychosocial processes relevant to this line of inquiry." She found the gerontological literature rarely focused on visual impairment, and the literature on blindness and visual impairment was concerned with children and young adults. Yet population data on visual problems suggested aged persons made up more than 50% of all legally blind persons, and 70% of those were defined as severely visually impaired (Horowitz 1988).

1.1 Visual Changes with Aging

The traditional area of investigation has been the physiological changes of the aging visual mechanism. Normal age-related changes include impaired ability to adapt to changes in light levels, extreme sensitivity to glare, decreased pupil size, reduced visual acuity, restricted depth perception, reduced contrast sensitivity, reduced retinal illuminance, reduced density of retinal cells responsible for low-illumination sensitivity (rods), and yellowing of the lens (e.g., Andreasen 1980; Horowitz 1988; Hughes and Neer 1981; Weale 1961, 1982). Binocular summation, the benefits of using two eyes instead of one, appears to have less benefit in old compared to young adults, and smooth-pursuit eye movements, which enable tracking of moving objects, also appear to be negatively affected by age (Kline and Scialfa 1996). Many changes

occur between the ages of 20 and 40 years; others such as the thickening and yellowing of the cornea and lens typically occur after age 40. Although colour vision is generally stable, discrimination of colour on the blue/yellow axis, particularly in low light conditions, declines past age 60 (Cooper et al. 1991). Changes in the minimum detail that can be discriminated in high-contrast targets, however, are not evident until the age of 70 (Kline and Scialfa 1996). Many of the visual changes evident with aging have lighting implications. A 60-year old person appears to require about 2.5 times as much light to see as well as a 20-year old (Guth 1957).

Reactions to some visual changes can produce profound behavioural changes. For example, aged persons may cease activities when they are confronted with low illumination. Commonly, they avoid night driving. They may even stop walking outdoors when there is poor contrast between figure and ground. Visual persistence, that is, the longer retention of an image in visual memory, increases with age, and makes fluorescent light flicker more evident to persons over age 65 (Kline and Scialfa 1996), which may contribute to inattentiveness and persistent headaches. Visual problems associated with aging have been implicated in falls, poor task performance, and changes in emotional state (Hughes and Neer 1981). Researchers concerned with physiology, however, typically do not spell out the practical implications of their results. Kline and Scialfa (1996), in reviewing the literature on visual aging, suggest research is needed on the impact of visual aging on the performance of everyday tasks.

1.2 Environmental Responses to Visual Deficits

Sensitivity to light, that is dark adaptation, contrast discrimination, colour discrimination, and glare and glare recovery, all show age-related effects (Kline and Scialfa 1996), but appropriate environmental design can reduce the effect of such deficits. For example, older eyes need longer to adapt to extreme changes in light, largely because of reduced retinal illuminance. However, a transition area prior to entering darkness (at a movie theatre, for example), can mitigate the effects of slow dark adaptation. Discriminating colour on the blue/yellow axis, such as distinguishing desaturated blue from green, can be avoided by not using both blue and green in places where the aged are expected to perceive them as different hues.

Elderly persons have increased difficulty in distinguishing figure from ground; that is, in interpreting important information from the environment when the background is distracting. A dark pattern on a floor, tile or a rug may be misinterpreted as a step, and a fall can occur when the elderly person inappropriately shifts body weight in anticipation of taking a step down. Appropriate contrasts are important for them to make visual distinctions. For example, contrast can highlight changes in floor levels or emphasize the presence of a handrail, making the environment easier to read.

Glare is a major problem for aged persons. With age, the lens of the eye acquires surface variations that refract light, much like a diamond's many surfaces refract more light than an uncut stone. Increased refraction makes the aged more vulnerable to glare discomfort. They commonly avoid areas with high glare. Light reflection on mirror-waxed floors has been blamed for falls, and the excessive glare in bathrooms is considered a factor in the high number of accidents reported there (Hiatt 1978).

1.3 Housing Environments for the Aged

Considering the average age for those in retirement settings, assisted living sites, and continuing care centres is over 80 years, the residents of such settings can be expected to have visual deficits such as those discussed above. They need prosthetic environments; that is, settings that compensate for their physical handicaps and physiological deficits. Otherwise their behaviours may be compromised, or they are apt to curtail their activities. Insufficient light and high glare may cause them to withdraw. Inappropriate contrast and glare may precipitate falls. Good lighting, on the other hand, is associated with a better quality of life for elderly persons according to an experimental longitudinal study (Sörensen and Brunnström 1995). Both ambient lighting and task lighting are important considerations. Sufficient ambient lighting ensures elderly residents can see their surroundings and may result in renewed interest in their environment. Task lighting supports their activities, but because the type of activity may vary from person to person, IESNA (1998, p. 14) says "the optimum solution for task lighting is to give the user control over the intensity and positioning of the light source to meet his or her individual needs."

With inappropriate lighting standards for the aged in use for many years, it is not surprising that insufficient lighting is now recognized as one of the biggest problems in settings in which they live (Brawley 1997; IESNA 1998; Noell 1992; Nursing Homes/Long Term Care Management 1998; see Appendix A). Some hospital-like long term care centres may have based their lighting systems on the IESNA medical and hospital lighting schedule (IESNA 1995). However, there is little reason to believe that the medical and hospital lighting schedule is appropriate for settings for elderly persons. The schedule was developed for the visual needs of medical practitioners (Brawley 1997), and likely advises high light for nursing stations but not for areas where residents read.

Lighting practices in health care settings have been changing, possibly for the worse, with the trend toward residential style settings. Newer continuing care settings have used more incandescent lighting in an effort to appear more homelike and residential, and thereby enhance their image. They have incorporated wall sconces along halls, rather than the fluorescent panels typically associated with health centres. The most problematic fixtures in this "mood lighting," Hiatt says, are crystal lanterns, sconces, or chandeliers that offer little lighting, but create a bright spot (1978). The fixtures may cost more but provide less illumination, lowering ambient lighting levels in newer settings.

Health and Welfare Canada (1988) has suggested three reasons why good exemplars of lighting in settings for the aged may be rare. First, appropriate lighting design practices are unknown to many designers. Second, developers may reject direct initial costs of recommended lighting, believing them to be too expensive. Third, design goals may be neglected during construction. The need for exemplars is especially great at this time, because many new settings are being planned to meet the needs of an aging population. Persons aged 75-85 will make up over 32 percent, and those over age 85 will make up over 14 percent, of all seniors by 2011 (Statistics Canada 1993). Approximately one-quarter of the total population in Canada will be over age 65 by 2031. In particular, there is a small building boom underway for settings designed for the care of persons with Alzheimer's disease. The need for settings arises from an increased incidence, associated with an aging population. There is a strong association between Alzheimer's disease

and age. The Canadian Study on Health and Aging found that 8% of Canadians over the age of 65 and 35% over the age of 85 years suffer from some form of dementia (1994). Approximately two-thirds of dementia cases are attributed to Alzheimer's disease, a disabling neurological disorder that primarily affects memory. It has no cure, but appropriate care can reduce its disabling effects.

As people grow older, they become more dependent on their environment to compensate for increasing frailty and sensory loss (Lawton and Nahemow, 1973). This is especially true in Alzheimer's disease. Consequently, authorities in the last decade have recommended specific improvements to the environment to compensate for the substantial losses in memory sustained by persons with Alzheimer's disease (e.g., Calkins 1988, Cohen and Weisman 1991, Coons 1985). The industry has responded by constructing small residential centres for persons with Alzheimer's disease who can no longer live with their families.

1.4 Visual Problems Associated with Alzheimer's Disease

In addition to all of the visual changes associated with normal aging, persons with Alzheimer's disease are known to have a variety of unique visual problems that are poorly understood (e.g., Brouwers et al. 1984; Cronin-Golomb 1995; Editors, 1994; Herlitz et al. 1995; Hinton et al. 1986; Nissen et al. 1985; Sadun et al. 1987; Steffes and Thralowe 1987; Trick and Silverman 1990). They also have perceptual processing deficits, particularly in selective attention and cognitive encoding, which affects their ability to comprehend multiple environmental stimuli at a rapid pace (Rosswurm 1989). Unfortunately, much of the research on vision and Alzheimer's disease has methodological problems such as small study sizes and unspecified diagnostic criteria, and little of it has been replicated. However, given those limitations, it appears that persons with Alzheimer's disease have a more acute need for a prosthetic environment than other elderly persons. They have more differential impairment in blue-hue discrimination, depth perception, and contrast sensitivity (Cronin-Golomb 1995). In advanced stages of the disorder, persons who were clinically described as "bumping into door frames, other patients, and objects" were found to have visual field limitations. The researchers diagrammed this with photographs of a hospital corridor with the exact mean isopter scores of the Alzheimer's patients in their study. In contrast to a photograph representing normal vision, the former corridor looked like a very dark tunnel relieved only by a very bright light at the end, which was created by a window and window reflection on a shiny floor (Steffes and Thralow 1987).

Glare, which inhibits activity for alert persons, is a factor contributing to excess disability in persons with dementia. Excess disability occurs when other conditions besides the disease contribute to their impairment. For example, when persons with Alzheimer's attempt to talk to reflections in windows or glass doors, as if they perceived others there, they appear more demented than they would in other situations. Light sources that produce double shadows, which may appear to follow the person (because one may advance when the other withdraws), have been observed to frighten persons with Alzheimer's disease.

Like glare, poor visibility can contribute to excess disability. A person's failure to recognize familiar faces in inadequately lit halls can have an impact on his or her social life and convince caregivers that memory impairment is worse than it actually is. Brawley suggests persons with

Alzheimer's disease are psychologically harmed by inadequate lighting. "If they have difficulty seeing or are unable to avoid problem areas, such as a poorly lit dining room, residents may endure daily torment that may lead to additional serious problems such as anxiety, confusion, and anger" (Brawley 1997, p. 86-87). For Alzheimer's disease, she has suggested that design professionals raise the level of illumination, eliminate glare, provide access to natural daylight, provide consistently even light levels, provide gradual changes in light levels where changes are necessary, provide focused task lighting, and improve colour rendition from lamps or light sources. Several reviewers have rated Brawley's book on design for Alzheimer's disease as the best resource available for architects and designers concerned with this disorder (e.g., Koenig-Coste 1997). A chapter on lighting discusses her recommendations, which are based on her experience as an interior designer and as a caregiver for a parent with Alzheimer's disease. She notes field research is meagre, but there is little field research with elderly participants, demented or well.

One recent study credits experience with "virtual sunlight" for the cessation or reduction in the insomnia and nocturnal wandering of three persons with Alzheimer's disease (Rheaume et al. 1998). Daily light therapy was provided in a residential-style treatment room that gradually raised the level of light emanating from the ceiling to 10 000 lux, providing virtual sunlight. At the resident's eye level, when they were not looking directly at the light, the light level was approximately 2 500 lux. The light therapy was also credited with reducing vocal disruptiveness in two of the residents. In contrast, a study examining low levels of lighting reported that the repetitious behaviours of 16 residents decreased in frequency when fluorescent lights on the unit were off and returned to baseline frequency when the lights were on (Ford et al. 1987). Actual light levels were not measured.

The biological implications of artificial illumination have been of concern for many years (Rusak, Eskes and Shaw 1996; Wurtman 1969). Research has shown that the effects of windows and natural light are physiologically important to sleep patterns and psychologically important to cognitive orientation (Olds and Daniel 1987; Verderber 1986). Most indoor light is considered a poor substitute for natural lighting.

1.5 New IESNA Recommendations and Field Research

Authors of the new IESNA age-adjusted recommendations have called for field research to test the recommendations and perhaps to suggest extensions. The document was issued for trial use and comment in 1998, and revisions are scheduled to begin after June 2001.

The present field study was concerned with lighting in two residential care setting for persons with Alzheimer's disease, a special population not addressed in the new IESNA document. Illuminance was objectively measured in the settings, residents were observed, and their professional and family caregivers were asked to rate the quality of the lighting. The results will contribute to the discussion of the appropriateness of new standards, and extend current knowledge on both the design of residential settings for elderly persons and the day-to-day activities of persons with Alzheimer's disease.

CHAPTER 2 – STUDY OBJECTIVES AND METHODS

2.1 Study Objectives

This study compared lighting levels at McConnell Place North (MPN) and McConnell Place West (MPW), two nearly identical sites serving the same population, to determine how different the lighting was, whether any behavioural differences occurred in the two settings that might be attributed to lighting levels, and whether lighting fixtures that were residential in style met new recommended IESNA recommendations. Both MPN and MPW were built before the new IESNA age-adjusted lighting recommendations were published, so neither centre was designed to meet those recommendations.

More explicitly, the research questions were:

1. How did the enhanced lighting levels in MPW compare with the 1998 age-adjusted IESNA illumination recommendations, and did they compare to recommendations from research?

2. How much did lighting levels in MPN vary from lighting levels in MPW and from the IESNA recommendations (as well as recommendations in the gerontology literature, if they differed from the IESNA recommendations), and how much of the variance between the two centres was attributable to natural daylighting through windows and the physical attributes of the space (such as differences in colour of walls and floors, etc.), rather than to light intensity and known characteristics of the artificial illumination?

3. Were staff members satisfied with lighting levels for activities at MPW, and how did this compare with staff members' satisfaction with lighting levels in MPN?

4. How did residents' utilization of public areas compare in MPW and MPN?

5. Were family members satisfied with lighting levels in MPW, and how did this compare with family members' satisfaction at MPN?

2.2 Methods

2.2.1 Description of the Relevant Physical Features and Centre Programs

This field study was done in two centres in Edmonton, Alberta. Both settings, MPN and MPW, were new, specially built residential care centres for the care of persons with Alzheimer's disease and related dementias. A description of each centre was composed from administrative records and interviews. Initial reviews were done of administrative records, such as program documents, blueprints, construction records, and promotional literature used to raise capital funds in the community. Also consulted were a post-occupancy evaluation for MPN (Milke 1997, 1998) and the description of MPW in a recent publication of Canada Mortgage and Housing Corporation (CMHC 1999). Subsequent investigations included discussions with corporate and design professionals involved in the construction of MPN and MPW, suppliers for the projects, and

building maintenance managers. Information was compiled to allow comparison of relevant features at the two centres. Appendices are provided comparing the two centres on room sizes (Appendix B), room finishes (Appendix C), window sizes and window glazing (Appendix D, Appendix E), specifications of lighting fixtures and colour temperature (Appendix F), and other features of the buildings and their orientation (Appendix G).

2.2.2 Objective Measurement of Ambient Light – Light Meter Readings

Light meter measurements were systematically taken for day and night in all public areas and two private areas in both MPW and MPN. Measurements were also taken outside at the windows on to the backyard and on to the front yard at each centre.

The timing of the light meter readings with respect to the hours of the day, as well as the day of the month (i.e., phase of the moon), was considered important, if not critical to the research. Because natural lighting was considered an important factor, nighttime measures were timed to avoid the full moon and targeted for a day close to the new moon on October 20, 1998. However, the change from daylight savings on October 25, 1998, which provided an extra hour of darkness for night measurements, helped with an additional concern regarding residents, discussed below. Consequently, both day and night measurements were done on October 26 (MPN) and 28 (MPW), 1998. At MPN, day measurements were taken between 11:10 a.m. and 1:25 p.m., and night measurements between 5:30 p.m. and 7:10 p.m. At MPW, day measurements were taken between 11:05 a.m. and 12:50 p.m., and night measurements between 5:30 p.m. and 7:00 p.m. Nighttime measurements at both centres began in windowless rooms (Appendix D).

Measurements were done in two occupied bedrooms and ensuite bathrooms at each centre because of the possibility family or staff members might comment about such lighting on the survey that was another component of this study. Timing of measurements for the private areas included in the study was a concern. The centres were considered the residents' homes, and the bedrooms their private space. The research team did not want to upset any resident with an intrusion on their private space, nor inconvenience them. Thus it seemed advisable to take night measurements in resident bedrooms early enough in the evening so that residents were still participating in social events, rather than getting ready for bed. The days immediately following the change from daylight savings time provided the ideal opportunity to obtain measurements early in the evening and yet have nighttime darkness outside. The windowless ensuite bathrooms were measured soon after 5:30 p.m.

The representative bedrooms were selected by asking care staff to identify a bedroom with the highest possible level of natural light and one with the lowest possible level. This resulted in bedrooms being chosen from the Blue and Green houses at each centre (each centre had residential wings designated Blue, Rose and Green house for the dominant colour scheme used). The highest natural light was expected in the bedroom nearest the kitchen in the Blue house, at MPN because of the south-facing window, and at MPW because of the west-facing window. In the Green houses at both centres, an awning over the patio shaded the windows of the bedrooms nearest the kitchen. Thus, the lowest light was expected in that bedroom. At MPN, the window faced north and at MPW the window faced east.

Residents, as well as staff members and visitors were expected to be present in all public rooms when measurements were taken. The IESNA manual advises that field measurements should include "the worker in his or her normal working position" (IESNA 1993, p. 62). Staff wore street clothes; therefore, the reflectance from their clothes was not systematically different from those of residents and visitors.

All lights, general and supplementary, were on during readings, as the manual advises, and all doors that could affect the lighting of a room were closed. For example, to bar light from bedroom windows, the bedroom doors were closed when measurements were taken for bedroom halls. All fluorescent lights were turned on more than 1 hour before measurements were taken to allow them to reach maximum intensity.

All measurements were completed by a Certified Engineering Technologist from Beaubien Glover Engineering Inc. who had two years' field experience (after graduation from the Northern Alberta Institute of Technology, Edmonton). For both daytime and nighttime measurements the technician used a hand-held Cal-Light 40 made by Cook Manufacturing. The instrument was professionally calibrated the week before the measurements were taken. Appendix H has the instructions used by the technician and researcher for taking light meter readings.

As the technician took each measurement, a researcher recorded it on prepared forms, verifying correctness as she wrote. Other information recorded on the forms included: date and time of day, room being measured, internal lighting conditions, external lighting conditions, grid pattern used for taking measurements, height of light meter from floor, and actual measurements. Readings were simultaneously coded to centre blueprints to assist in correlating measured lighting levels with light fixture locations within the centre. The relatively small scale of the blueprint meant that the recorded location was only a rough estimate of the exact location of the measurement.

Basic light meter measurements were done on a "cursory" grid, a procedure based on that used by Mital, Ayer and Gorman (1992) for their evaluation of lighting levels in an award-winning seniors' residence. Measurements done on an intensive grid would have required measurements every two feet (IESNA 1993). Mital et al. reported minimum, maximum, and median measurements for a number of rooms and a few tasks.

The grid measurement strategy in this study involved taking an equal number of measurements under and in between light sources. However, if light sources were in a row beside a window and in a row a distance from a window, then measurements were done under an equal number of light sources near, and away, from the window, as well as in between the light sources in both locations (Appendix H outlines the method by room). The technician and researcher attempted to obtain measurements in the darkest possible areas in each room, as well as in the brightest probable areas with respect to lights and windows. However, they measured along walking paths in halls, rather than just inside windows or against walls. They always attempted to obtain a measurement for the midpoint of the room. An average of 10 to 15 readings were taken per room.[2] Minimum and maximum readings reported here were the darkest and brightest readings

[2] Bathrooms, because of their size, had only 5 readings, and, because of their length and breadth, the hallways had 21-23, which included readings at floor and face level.

in the room/hall, respectively (reported at the height being used in the appropriate table, i.e. 30" or face height). Median readings were the midpoint in the ascending sequence of light readings. If there was an even number of readings, the two middle readings were averaged to obtain the median. Standard measures were taken using a portable stand that positioned the light meter in a horizontal plane and maintained it 30 inches above the floor, (IESNA 1993). When industry standards suggested measurements at other heights, these were done. For example, measurements were taken at floor and face levels in halls. Grid measurements provided information on ambient lighting.

Task lighting was measured in all common and shared rooms within both centres, except the bedroom halls. For example, measurements were taken at the arm height of any chairs and sofas, at shelf heights, and coffee table heights. In addition, lighting was measured at dining table place settings, the music rest on the piano, at sink height for kitchens and bathrooms, the mirror at face height, at regular intervals along counters, the tops of the toilets and bathtubs. Measurements were also taken at the television screens, although IESNA had no recommendation for television areas or television screens. Measurements were taken at face height where appropriate, such as in a hall where light should illuminate the face to facilitate recognition. When measurements were taken, the light meter was located so that the surface of the light-sensitive cell was in the plane, horizontal or vertical, that was appropriate to the task; that is, to the portion of the work relating to the essential visual task (IESNA 1993). For example, the vertical plane was used for mirror measurements and measurements outside the windows; otherwise the meter was held on a flat horizontal level. Task measurements were believed to indicate the lighting levels that were most relevant for residents. They might identify spots within a room with either high or low lighting that could be missed by grid measurements.

Face level measurements were taken in all halls as a component of the task lighting. The method raised a different type of gerontological issue. The lighting technician used a height of 5'8," his nose height, which provided normal facial reflectance for the light meter reading; however, the height was likely inappropriately high for the population. Elderly persons are generally shorter. The manager of MPN estimated the average "nose height" for her residents at 5', and the manager of MPW at 5'6", because MPW had more male residents. Their estimates were requested after the face-level measurements were added to the research design. Data from the light meter measurements were entered in SPSS for analysis.

2.2.3 Survey on Lighting Adequacy for Various Resident Activities

2.2.3.1 Procedures for Staff Members

Staff and residents' family members were asked to complete a survey prepared for the study to determine whether they perceived lighting levels to be adequate. The survey used the same format as Mital, Ayer, and Gorman (1992, see Appendix I) and asked where the person would engage in 16 different activities, the time of day this would occur (ranging from the morning hours of 8-11 to the early evening hours of 4-8), the length of time of the activity, and whether the person considered the lighting adequate in the area from the residents' perspective. The survey included a page requesting information about the respondent such as gender, the use of glasses and whether he or she had visual problems. The question about age provided ranges for

the person to circle. The ranges (under 40, 41-50, 51-70, and over 70) were chosen because of visual changes known to occur at ages 40, 50 and 70 (Kline and Scialfa 1996).

The lighting survey was distributed in November 1998 at both centres through staff mailboxes. The researchers asked the managers of the centres to take whatever opportunities presented to urge staff to complete their survey forms. The direct care staff included personal caregivers and licensed practical nurses, all of who were considered by the managers to know the residents and the day-to-day functioning of the centre very well. The complement of personal caregivers, called Resident Companions, at MPN included 11 full-time, 15 part-time, and 7 casual staff; and at MPW, 11 full-time, 14 part-time and 5 casual staff. The LPN complement at MPN was 3 full-time, 3 part-time, 4 casuals, and at MPW was 3 full-time, 3 part-time, and 1 casual. The support staff (housekeeping and maintenance) at MPN were 2 part-time and 2 casual, and at MPW were 1 full-time and 2 part-time. Because only full-time and part-time staff were included in the survey, the numbers of staff were identical at the two centres (i.e., 14 full-time and 20 part-time at MPN, and 15 full-time and 19 part-time at MPW). All but casual staff were requested to complete a survey form. In addition, the managers, clerk/receptionists, and program coordinators at each centre were asked to complete forms. All of these administrative staff members knew the residents very well, and were very familiar with daily life in the centre.

2.2.3.2Procedures for Family Members

The same form was used for both staff and family members (Appendix I). Only one family member, typically the legal guardian of the resident, was contacted by mail and asked to participate. The single contact per family was done in an attempt to inhibit bias. At focus groups in the past at MPN, large family representations tended to bias discussions.

Each centre housed 36 residents, thus 72 surveys were sent to family members in November 1998. A repeat mailing was scheduled for January 1999, and the managers agreed to appeal to family members to return survey forms at the next regular meeting (February) held by each manager for all family members. Data from both surveys were entered into SPSS for analysis.

2.2.4 Method for Observing Behaviour

Location-centered behavioural mapping was done to determine the use that residents made of public spaces (Milke 1989; Sommer and Sommer 1986). A behaviour map is the observed data collected during a quick scan of an area or areas. This is the method of choice when a central question is whether rooms are suitable for those who occupy them. Data indicate how people disperse themselves within a building and how they use the areas provided, information that can help planners make decisions about changes that might be necessary in physical design, policies or practice. Participants' reaction to being observed is a problem with any type of observation (Kazdin 1982; Sommer and Sommer 1986; Zeisel 1981). Behaviour mapping is one of the least intrusive methodologies for observing what people do and where they do it. Quick scans have the advantage of allowing very little time for the person being observed to adjust their behaviour to make it more socially acceptable; therefore, scans are preferable to some other types of observation like the continuous observation provided by video camera. Moreover, because

people often do not appreciate being observed, scans may be received more positively by staff than videotaping.

In research focusing on the location, rather than on individuals, only a person's classification is noted (i.e., staff, visitor, resident, other), not the identity of the individual. The location of persons are noted, as well as their activities, using a schema in which behaviours are defined to be exhaustive and mutually exclusive. When only the classification of a person is noted, rather than their individual identity, the data gathered cannot provide information about particular residents, staff members, or visitors. Thus, from the beginning the information is anonymous.

Scans were done hourly from 8:00 a.m. to 9:00 p.m. on two weekdays at each centre. Each scan at MPN and MPW produced one behaviour map that represented a systematic real-time observation, a time sample, of all of the people within all the public spaces in the centre. A bird's-eye view of all locations and simultaneous observation of them would have been ideal. As a substitute, the viewing was done sequentially as rapidly as possible. Typically, many rooms were scanned within a 10-minute period. Past experience has determined that two days' observation are sufficient if analysis indicates the days are not significantly different on the basic types of information recorded (Milke 1997).

To keep the observations minimally intrusive, observations were only done in public, shared spaces, not in private spaces such as residents' bedrooms, nor in bathing areas. The presence of staff and visitors was noted in all public locations, but their activities were not recorded. Residents' activities, however, were recorded in detail. For example, observers were asked to note whether residents' chores were easy housekeeping tasks, cooking and baking, or clerical tasks, and whether residents' leisure involved one of 11 different activities, ranging from arts and crafts to woodworking. Residents' activities (22 in all) in the observational scheme corresponded to the activities listed in the questionnaire sent to staff and family members. Instructions for observers and definitions of activities are provided in Appendix J.

The data provide an estimation of time budgets, that is, how persons in the setting spent their day, because they were obtained through systematic sampling. The percentage of time spent can be determined for: locations, activities, activities by location, locations by hours of the day, activities by hours of the day, and activities by location by hours of the day. The unit of analysis is the behavioural event.

Although activity was not observed for family or staff members in the present study, previous observations have shown they engage in a very narrow range of types of activities. Earlier observations at MPN found that staff were either working or walking as part of their work, for approximately 95% of the time (Milke 1997, 1998). Not surprisingly, visitors were "visiting" the majority of the time they were in the centres; that is, they were communicating with residents, were engaged in the same leisure activities as residents, or were walking with residents. In a recent study of five residential settings, including MPN and MPW, over 90% of staff activities were classified as "working" (Milke, Beck and Ledewitz 1999). Family members who were observed in the study spent over 60% of their time visiting, and nearly 30% of the time helping the residents by walking with them or assisting with some activity of daily living.

CHAPTER 3 – DESCRIPTION OF THE CENTRES AND THEIR RESIDENTS

3.1 McConnell Place North and McConnell Place West

The two centres, McConnell Place North (MPN) and McConnell Place West (MPW), in Edmonton, Alberta, were specially built residential care centres for the care of persons with Alzheimer's disease and related dementias. MPN, which opened in 1995, was purported to be the first specially designed care centre for Alzheimer's disease in Canada. MPW opened in 1998. Both are operated by a publicly owned corporation in the Capital Health Region in Alberta, *The* Capital Care *Group*. It operates seven other long term centres, a number of group homes, and two day hospitals modelled on the PACE[3] model of care.

The small one-storey centres each housed just 36 residents. Each building had residential wings, referred to as houses, linked by a shared common area. The wings were colour-coded to assist with way-finding (Green, Rose, and Blue in Figures 1 and 2 at the end of the chapter). An administration area was well-separated from resident space. In MPN and MPW, three parallel wings, flanked by courtyards, made the shape of a capital letter E. Gardens filled the spaces in and around the E-shape. The common areas in both centres had large glass panel doors opening onto a large patio and secure garden and yard. A path led to smaller landscaped areas and patios associated with the three residential wings and several doors at each wing. MPN, for example, had seven doors to the outdoors and 20 variations on the pathway. Each wing was self-contained; that is, had a kitchen, living-dining room and laundry, and a room for bathing. A bedroom hall in each wing had 10 private and 1 semi-private resident bedrooms, each containing a three-piece bathroom. At MPW, the bedroom windows faced east-west, and at MPN north-south. The house kitchens at MPW were larger than at MPN, where they were intended to be serveries. The living-dining rooms and bedroom halls were also more spacious in MPW and, where four bedroom doors opened into the central section of each bedroom hall, the ceiling was vaulted.

There were some other differences between the centres in how space was distributed. MPN had two extra special purpose rooms, a music room and horticulture room, in the common area that joined the three houses together. In addition, the centrally located craft room at MPN became the office and supply room for the activity convenor at MPW. At MPW, a storage area was converted into a craft room. In fact, none of the activities for which the special purpose rooms were named at MPN were relinquished at MPW. Musical instruments, an organ and piano, were located in the great room, and a place for indoor gardening was added near a patio door at one outdoor courtyard. Changes were made at MPW because a post-occupancy evaluation at MPN indicated residents made little use of these special purpose rooms (Milke 1997, 1998). Residents appeared to prefer to spend time in their three houses, and small group activities were easier to run in the houses than in a dedicated area. The removal of the horticulture and music rooms provided the space within the building footprint at MPW for the larger kitchens, larger living-dining rooms, and wider bedroom halls in the houses.

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[3] PACE, or Program of All-inclusive Care for the Elderly, began as a U.S.-wide demonstration program to test the replicability of the On Lok managed care program in San Francisco that combined medical, social, and supportive services under a multidisciplinary team. The Capital Health Authority in Alberta replicated the program, the first in this nation, under the auspices of one of the U.S. PACE sites.

The general floorplans of MPN and MPW were very similar. The footprints were mirror images of each other (see Figures 1 and 2). The total square footage at MPN was 24 725 and at MPW 23 864. Of this, the square footage of the administration area was 1675 at MPN and 1623 at MPW. A number of small adjustments, and some large ones, like staff locker space, accounted for the differences between the total square footage of the two centres. Other features, such as window placement and glazing, and many components of the décor, were found to be very similar (Appendices B to G).

Residents could move freely through the common area and the houses, and in reasonably good weather into the secured garden areas through a number of doors in the common areas and in the houses. The common area hall had several segments referred to here as the front street hall, the Green area hall, the Rose area hall, and the back patio hall (Figures 1 and 2). These formed a large loop linking various common rooms. In one area, a window wall looked onto flowerbeds and shrubs; in another, onto visitor parking and the street. The common areas in both centres included a great room, a library seating area, a family or private dining room, and a beauty salon.

When MPN, the first centre, was planned in 1994, designers focused on maintaining a residential appearance throughout the three residential wings and the central core that provided a number of activity spaces. Inside and out, the centre looked like a small residential hotel. Because a social model of care prevailed, rather than a medical model, and because the construction conformed for the most part to the residential building code, residential-style lighting was considered an important design component.

After MPN opened in 1995, lighting became a concern. The post-occupancy evaluation (Milke 1997, 1998), completed to uncover physical problems that might be improved in MPW, used an environmental scale[4] from the three-year National Institute of Aging Collaborative Studies on U.S. settings for Alzheimer's disease. Some areas of the centre were judged to have low lighting levels, considering the average age of residents was over 80 years. Interviews with some members of the original planning team suggested low lighting levels might have resulted from purposeful attempts to enhance the residential nature of the care centre. During construction many building materials had been evaluated on the basis of whether they contributed to the residential appearance or detracted from it. Some of the lighting fixtures originally in the blueprints were deleted because planners wanted to ensure that facility-style lighting, common in other centres caring for persons with Alzheimer's disease, was not used. The lighting engineer suggested the decorators intended to rely heavily on table lamps and trilight floor lamps, assuming that free-standing lamps could increase lighting levels where needed. However, in the post-occupancy evaluation focus groups, care staff raised several types of lighting issues. They believed that free-standing lamps could not satisfactorily augment lighting levels (Milke 1997, 1998).

Improving the lighting levels was considered a priority by *The* Capital Care *Group*. It arranged for light meter measurements in the resident areas of MPN. This confirmed that lighting levels were very low in some areas, and very uneven across some rooms. For example, in the library seating area at 5:30 p.m. on June 19, 1996, with all lights on, illumination was 215 lux at the top of a coffee table in the middle of the area. This level was considerably lower than the range of

[4] The Therapeutic Environmental Screening Scale (version 2+) or TESS-2+ (Sloane et al., 1995).

500-1000 lux recommended for nursing home residents by a gerontologist (Hiatt 1991). Interestingly, residents were observed to spend little time in areas with low lighting, but other factors such as staff preferences were thought to play an important role in this. Staff members appeared to prefer to lead activities in the great room, rather than the small special purpose rooms or in the library area.

A pilot test on four public rooms was done at the first centre to determine how much illuminance could be augmented by changing bulbs in existing fixtures (Milke 1996). The enhanced lighting did not increase lighting levels enough to meet the recommended levels found in the gerontological literature (e.g., Hiatt 1991). However, the information from the light meter measurements and the pilot test were used by *The* Capital Care *Group's* new planning team as they approved specifications for MPW. The second centre, MPW, was built in 1998 using the same building plans as MPN. Small changes, discussed above, were made to solve the issues raised in the post-occupancy evaluation of MPN. In some areas where light was particularly low in MPN, the engineer designing the lighting system for MPW increased the number of lighting fixtures, or changed the type of fixture, so that the lighting levels would be at least four times higher in specific areas parallelling those that were rated as having low light in MPN. Residential-style lighting fixtures again were used, but various strategies were adopted to enhance the lighting without increasing glare, reflected glare, or problems from veiling luminance; that is a luminance, usually from a highly lit background, that becomes superimposed on the retinal image of a foreground object reducing contrast perception. In the MPW great room, the major gathering space for exercise groups and large social events, the lighting engineer found a way to bring light in through a strategy similar to a skylight and bounce the light across the room. The clerestory windows in the first centre's great room had received a number of negative comments from staff because the sun's angle at some hours resulted in blinding light along one wall. At other times the room was too dark.

3.2 Resident Demographics

Both MPN and MPW admitted residents through the 'single point of entry' system used in Alberta for the long term care system, but limited their clientele to those with Alzheimer's disease or related disorders. Residents typically had evidenced some symptoms that indicated they required a secure environment with assistance provided by staff specially trained in dementia care. Typically, residents received help with activities of daily living, but none required simultaneous assistance from two caregivers. In most instances, staff provided guidance rather than performing tasks for the residents. A resident was discharged when care needs could no longer be consistently met with current staffing, or when medical status was unstable, or when the resident had consistent behaviours that were detrimental to other residents and required daily intervention of at least 30 minutes. When a resident met discharge criteria, transfer was arranged to a long term care centre.

Each centre had 36 residents at the time of the study, a full complement. At the time of the study, all had a primary diagnosis of Alzheimer's disease. The average number of concurrent diagnoses per resident at MPN was 3.3 and at MPW was 4.0, and the modal number of diagnoses was 3 at MPN and 4 at MPW. This was not a significant difference. Visual problems were noted in several residents' charts. At MPW, 2 residents had glaucoma, 1 had cataracts, and 1 had "tunnel

vision," a visual disturbance that was being monitored and was assumed by the care manager to be associated with glaucoma. At MPW, 20 wore glasses with corrective lenses. At MPN, there was only 1 diagnosis of cataracts, and 27 wore corrective glasses.

At MPN, 89% of the residents were women, whereas at MPW, 72% were women. The high percentage of women was expected. Typically, the vast majority of residents in long term care settings are women. The number of men at MPW was significantly different than the number at MPN ($\chi^2(1, N = 36) = 11.70, p < .001$). The average age of MPN residents at the time of the study was 81, ranging from 68 to 96 years, and at MPW the average was 83, ranging from 59 to 93 years.

Figure 1
Floorplan of McConnell Place North

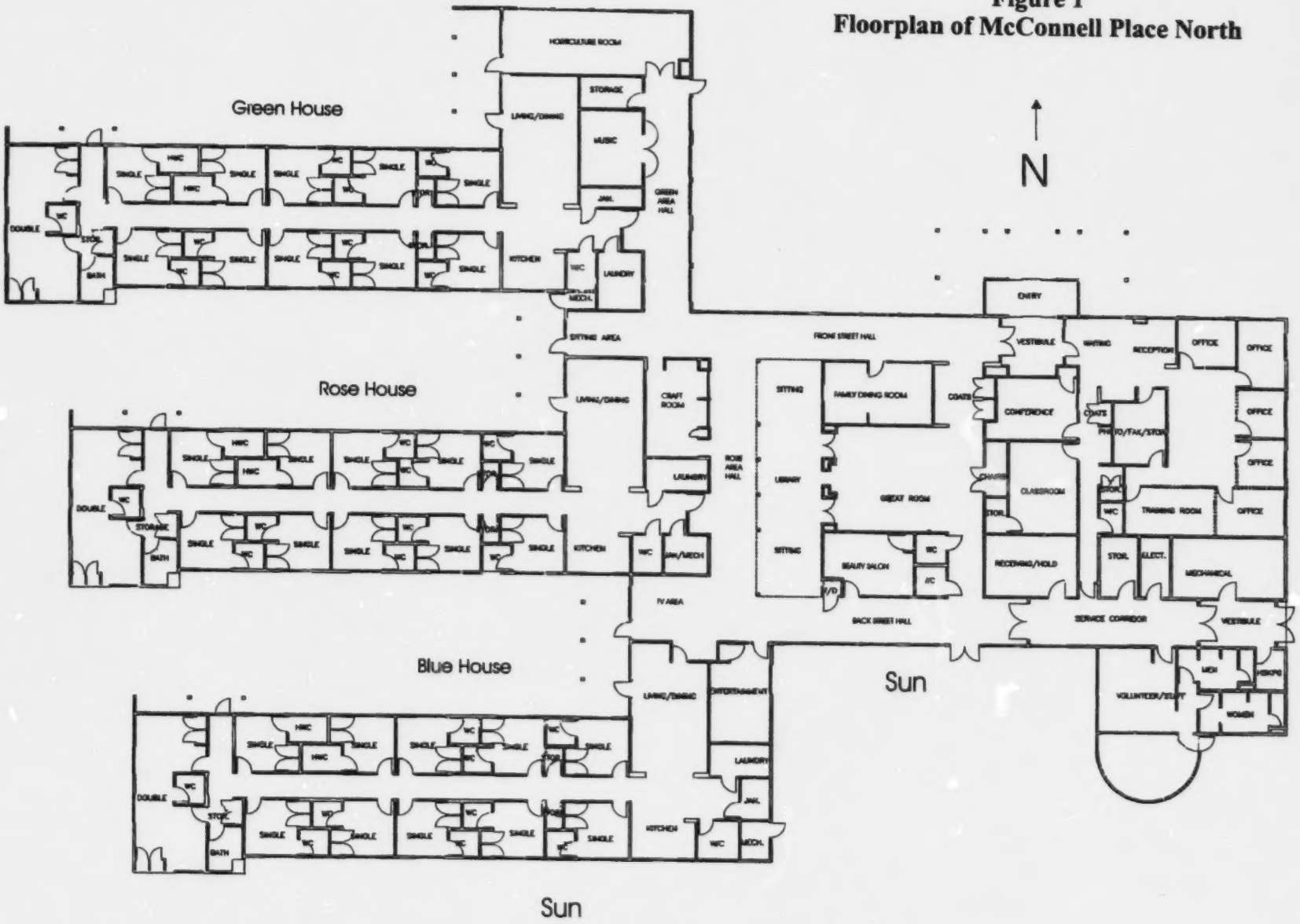
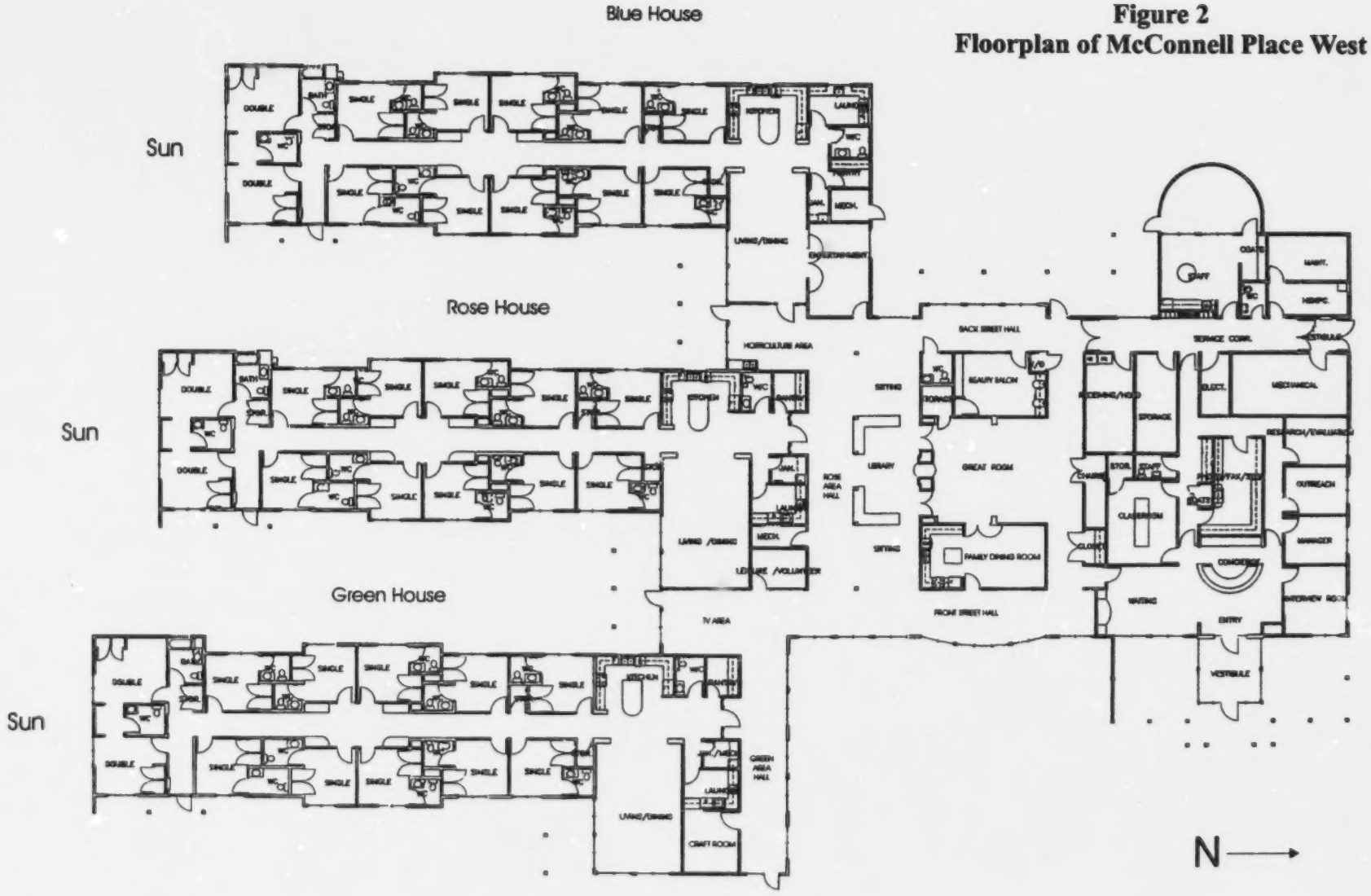


Figure 2
Floorplan of McConnell Place West



CHAPTER 4 - ILLUMINANCE, JUDGEMENTS, AND OBSERVED BEHAVIOURS

4.1 Results of Light Meter Measurements

Measurements were taken at both centres when natural lighting was apt to be at a maximum level; that is, between 11:00 a.m. and 1:30 p.m., and when nighttime darkness in late October was well established, between 5:30 p.m. and 7:15 p.m. Unfortunately, exterior daytime conditions were not identical on the two days. It was constantly bright and sunny for MPN measurements, and bright sunshine was intermittent for MPW measurements.[5] In a study such as this, the effects of natural daylight and artificial lights are inextricably mingled so that the elements cannot be distinguished or separated. Moreover, it can be difficult in some geographical areas, such as Alberta, to be certain that a sunny day will remain sunny throughout the period of measurement. Nighttime measurements were not confounded in the same way as those done in daytime. Therefore, nighttime measures are a better indicator of whether the lighting system at MPW, which was designed to provide much higher lighting levels than at MPN,[6] actually achieved that result.

The weather in this study was not as problematic as it could have been, because it worked against the premise that MPW would have the better lighting of the two centres. That is, the centre without the enhanced lighting had the benefit of better natural lighting, and therefore it was measured in its best natural light, whereas the centre with enhanced lighting was not seen in its best natural light. If the natural lighting conditions had been bright and sunny for measurements at MPW, then its effect would have been in the same direction as the artificial lighting. This would have resulted in daytime readings that would have been more difficult to interpret. However, the intermittent sunshine during measurements at MPW resulted in smaller than expected differences between the MPW and MPN daylight measurements. Therefore, one can assume that differences found between similar areas in the two centres were reliable, and not merely an artifact of differences in sunshine levels. The chief problem with the intermittent sunshine during MPW measurements was that some were taken during bright sunshine, and some were taken when a cloud passed over the sun. Thus, areas within MPW cannot be compared as reliably as areas within MPN.

Table 1 compares measurements taken on the exterior of the window walls at the two centres. The light meter was held on a vertical plane. The orientation of the two buildings was a factor in the (south) back patio at MPN being much brighter than the (west) back patio at MPW. In Figure 1 and Figure 2 the word "sun" designates the exterior walls receiving direct sun at the time of measurement. The walls of the one-storey centres were the same height. They were not a factor.

The remarkable difference between the exterior measurements at the back patio window wall at the two centres is not entirely because of the orientation of the building and the difference in a south sun and a west sun at 1 p.m. A design difference in the two centres resulted in the window wall at MPN being in direct unprotected sun, whereas at MPW a roof overhang kept the window

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[5] The schedules of the technician did not permit rescheduling the measurements at MPW to "the next sunny day." To better equate weather conditions, other comparative studies might arrange for two technicians to do readings simultaneously or measure the same part of each centre on the same day and do readings over a series of days.

[6] See Section 3.1.

wall in shade. This is discussed further below, and the daylight diagrams in the 1998 IESNA document, *Lighting and the Visual Environment for Senior Living*, illustrate the effectiveness of such strategies.

Table 1
Comparison of McConnell Place North and McConnell Place West
Outdoor Light Meter Measurements
Measurements taken at 1 p.m.: at MPN on a constantly sunny day, at MPW in intermittent sun
All measurements in lux

	Daytime		Nighttime	
	MPN	**MPW**	**MPN**	**MPW**
Front Street window wall	2920 (North)	2150 (East)	1	0.5
Back Patio window wall	11 700 (South)	382 (West)	0.6	17*

* Patio lights with illumination at a height of 30" were located around the back patio at MPW.

Table 2

Ambient Light in Common Rooms in McConnell Place North and McConnell Place West

Grid measurements were taken 30 inches from the floor except in halls where they were taken on the floor.
MPN was measured on a constantly sunny day, MPW in intermittent sun. All measurements in lux.

	MEDIAN Daytime		MAXIMUM Daytime		MINIMUM Daytime		IESNA Minimum
Area*	MPN	MPW	MPN	MPW	MPN	MPW	
Beauty Salon	1339	901	1376	905	626	870	500
Craft Room	844	604	871	650	841	530	300
Entertainment Room	214	647	222	662	175	614	300
Great Room	1641	448	2055	525	1480	397	300
Horticulture Room /Area	1020	473	1127	510	784	416	300
Library Seating	275	740	801	1057	198	556	300
Music Room	204	–	246	–	156	–	300
Front Street Hall	527	628	550	921	480	537	300
Back Patio Hall	3160	450	31 620	527	1364	366	1000†
Green Area Hall	644	784	682	1090	543	726	300
Rose Area Hall	276	343	298	408	210	338	300
	Nighttime		Nighttime		Nighttime		
Beauty Salon	804	940	837	1913	319	902	500
Craft Room	822	604	827	650	800	530	300
Entertainment Room	78	521	81	613	18	459	300
Great Room	65	340	66	533	63	281	300
Horticulture Room /Area	739	500	775	513	650	413	300
Library Seating	204	670	285	1055	115	534	300
Music Room	159	–	196	–	92	–	300
Front Street Hall	96	275	219	360	64	200	300‡
Back Patio Hall	160	433	170	453	138	315	300†‡
Green Area Hall	144	333	150	337	107	320	300‡
Rose Area Hall	132	327	160	335	125	285	300

* Family dining room and television areas are not included here.
† 1000 lux is recommended in daylight, 100 lux during the night, because of direct outdoor access (light level requirements at entries are discussed).
‡ Residents were still active. The recommended level for halls is 100 lux during sleeping hours.

4.1.1 Comparisons of Common Areas in the Centres

4.1.1.1 Daytime Comparisons

Measurements for the back patio hall in Table 2 indicate sunlight coming through the unprotected south window wall at MPN. The maximum was 31 620 in the sunshine. The median measure was 3160 and the minimum 1364. In addition, under these natural lighting conditions, the clerestory windows on either side of the MPN great room admitted more light into the room than the reflector at the MPW ceiling, which was specially designed to admit and diffuse sunlight. When compared to MPW, MPN measurements showed greater differences between the median, maximum and minimum within most common rooms.

In spite of better natural daylight at MPN, the median, maximum and minimum measures were higher at MPW than at MPN in five areas of the common rooms: the entertainment room, the library seating, the front street hall, the Green area hall, and the Rose area hall. However, median, maximum, and minimum measures were higher at MPN than at MPW in the horticulture and craft areas.[7] The MPW horticulture area was not lit by fluorescent ceiling fixtures as at MPN. At MPN, the room also had window walls facing north and west. At MPN, the craft room in the centre of the building was not expected to be greatly affected by direct, bright sunlight. It was lit by fluorescent ceiling panels, and had two entrances, neither of which had doors. The east-facing wall had heavily frosted windows which were obscured by craft projects and game boxes. The MPW craft room had no other means of admitting daylight (Appendix D has detailed information on the location and size of all windows). The MPW craft room was a windowless storage room conversion with fluorescent ceiling fixtures. The craft room at MPN, with office-like fluorescent ceiling panels, was purpose-designed. The beauty salon at MPN had a higher median and maximum reading than the salon at MPW, likely because of its proximity to the intense light in the back patio hall; however, the minimum was lower. It, like most interior rooms, had glazed doors. Most also had glazed panels, except for the MPW craft room.

4.1.1.2 Nighttime Comparisons

At night the picture of ambient light changed. Table 2 indicates MPW had higher lighting levels for medians, maximums, and minimums than MPN in every room in the common areas with the exception of the craft room and the horticulture room. MPN showed larger differences between day and night measurements than MPW. For example, measurements in the back patio hall dropped from a median of 3160 to 160 at night, and a maximum of 31 620 dropped to 170 at night. The minimum during the day was 1364, whereas at night it was 138. Similarly the great room measurements all dropped from well over 1000 lux to approximately 60 lux, one-twenty-third of the daytime reading.

The largest change seen at MPW between day and night was in the Green area hall. The corresponding day and night measurements were: median 784 and 333, maximum 1090 and 337, and minimum 726 and 320.

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[7] The location of the maximum measurements varied from room to room, with the majority occurring closest to natural light sources. At times, maximum readings were found under the strongest artificial light available

The minimum in the great room at MPW was approximately 4.5 times brighter than the corresponding measurement at MPN. The same is true of the library seating area. Only the craft room and horticulture area at MPW had less illumination. Nighttime maximums or minimums for rooms were often in different locations than the corresponding daytime measurements.

4.1.1.3 Common Rooms Minimum Measures and IESNA Minimum Recommendations

All daytime minimum measurements for ambient light in the common areas at MPW and MPN, with the exception of the library seating area, music room, and Rose area hall at MPN, and the back patio hall at MPW, were higher than the new age-adjusted minimums recommended by IESNA (1998). At MPW, the nighttime minimum measures met the new age-adjusted minimums recommended by IESNA in seven areas, and were lower in three areas (the great room, the Rose area hall, and the front street hall). In contrast, minimum light levels at MPN dropped well below recommended levels at night. At MPN, only the craft room and horticulture room met and exceeded the recommended light level. At night, the great room minimum was approximately one-fifth of the recommended lux, although with a daytime minimum of 1480 lux it was well above the IESNA recommended minimum of 300 lux. Because residents were still active when measurements were taken, IESNA recommendations for halls during sleeping hours (100 lux) were not used for comparisons in Table 2.

Table 3

Ambient Light in the Houses at McConnell Place North and McConnell Place West

Grid measurements were taken 30 inches from the floor except in halls where they were taken on the floor.
MPN was measured on a constantly sunny day, MPW in intermittent sun. All measurements are in lux.

	ROOM MIDPOINT* Daytime		MAXIMUM Daytime		MINIMUM Daytime		IESNA Minimum
Area	MPN	MPW	MPN	MPW	MPN	MPW	
Green Living-Dining Room	125	839	180‡	842‡	121‡	512‡	300
Rose Living-Dining Room	150	887	188‡	700‡	132‡	642‡	300
Blue Living-Dining Room	181	807	207‡	736‡	162‡	574‡	300
Green Kitchen	331	698	360	708	301	687	300
Rose Kitchen	285	780	287	803	282	756	300
Blue Kitchen	593	830*	633	846	553	814	300
Green Bedroom Hall	92	250	543	402	36	159	300§
Rose Bedroom Hall	83	286	515	422	40	245	300§
Blue Bedroom Hall	98	270	511	424	51	147	300§
Green House Bedroom	147	192	319†	290†	59	32	300
Blue House Bedroom	29 900	156	29 900	156	766	27	300
	Nighttime		Nighttime		Nighttime		
Green Living-Dining Room	74	858	111‡	684‡	71‡	504‡	300
Rose Living-Dining Room	78	883	105‡	686‡	74‡	638‡	300
Blue Living-Dining Room	104	781	125‡	681‡	50‡	562‡	300
Green Kitchen	288	662	303	692	273	397	300
Rose Kitchen	221	590	235	744	206	494	300
Blue Kitchen	313	729	321	822	304	724	300
Green Bedroom Hall	82	245	101	395	24	119	300§
Rose Bedroom Hall	71	265	107	422	33	105	300§
Blue Bedroom Hall	80	255	110	409	28	132	300§
Green House Bedroom	88	63	222†	102†	35	21	300
Blue House – Bedroom	83	42	83	83	31	17	300

* Room midpoint measurements were taken 30" from the floor.

† The measurement was taken at 25".

‡ Measurements were taken on each of the four dining tables (28").

§ A door to the courtyard in the "T" section of the hall suggested that 1000 lux was necessary at the door during the day, 100 lux during the night.

4.1.2 Comparison of the Houses in the Two Centres

In the three residential houses, Green, Rose, and Blue, there were remarkable differences between MPN and MPW (Table 3). During daytime there was from 400 to 600 more lux in the living-dining rooms at MPW than at MPN, even though the measurements at MPN were taken on a constantly sunny day and those at MPW had intermittent sun. At night the differences typically increased, with minimums at MPN of 71, 74 and 50 lux, in contrast with minimums of 504, 638, and 562 lux at MPW. The same pattern of differences between MPN and MPW is seen in the kitchens and bedroom halls.

4.1.2.1 Brightest Bedroom

Staff selected the bedroom nearest the kitchen in the Blue house as the brightest bedroom. At MPN, this bedroom faced south and had no barriers to natural light. Meter readings were very high during the day and fell dramatically at night. Table 3 indicates the daytime room midpoint was 29 900 lux, a maximum for the room. The darkest daytime area, or minimum, was 766 lux. At night the midpoint measurement fell to 83 lux and the darkest area was 31 lux. At MPW, the Blue house bedroom in the same location faced west and had no barriers to natural light. The daytime room midpoint was only 156 lux and the minimum 27 lux. At nighttime the midpoint fell to 42 lux and the darkest area was 17 lux (Table 3).

4.1.2.2 Darkest Bedroom

The bedroom nearest the kitchen in the Green house was judged by staff to be the darkest bedroom. At MPN, the window for this bedroom faced north and was located under a metal awning for a patio. The daytime midpoint was 147 lux, but the maximum was 319 lux, the latter being brighter than any measurement in the MPW bedroom that staff rated brightest. The minimum was 59 lux, again brighter than in the MPW bedroom that staff rated brightest. At MPW, the bedroom faced east and was located under a metal awning for a patio. The daytime room midpoint was 192 lux and the darkest area was 32 lux, both of which were higher than the MPW bedroom rated brightest. At MPN, nighttime maximum and minimum were 222 and 35 lux, respectively, compared to a maximum of 102 and a minimum of 21 at MPW.

4.1.3 Task Lighting

Task lighting was another important consideration. The daytime and nighttime lighting levels available for tasks in various rooms at MPN and MPW are provided in Table 4. The IESNA age-adjusted recommendations for task lighting are also included. IESNA recommends the same level of task lighting for daytime and nighttime. The measured levels of lighting for a particular chair, however, were often very different at nighttime compared to daytime. For example, in the library seating area at MPN the daytime task lighting ranged from 159 to 784 lux, with only the latter meeting the recommended level for reading printed text (750 lux). These same chairs at nighttime ranged from 68 to 289 lux, making reading difficult. No other area with reading chairs provided the recommended light level at MPN (front street hall, Green area hall, and Rose area hall). The range in the library seating area at MPW did not vary as much from day to night. Daytime measurements ranged from 527 and 770, and nighttime from 421 to 789. Like MPN, no

other area with reading chairs provided enough light. Overall, the common rooms appeared to provide very few chairs with lighting at the recommended level for reading text.

The very high 32 500 lux at the bistro tables in the back patio hall in MPN, which was even higher than the exterior reading at the window wall along this hall (11 700 lux, Table 1), supported staff reports that residents avoided these tables for much of the day because of the heat and light. The light meter was held on a different plane for measurements indoors and out as required by industry measurement standards, which would account for some of the difference. Reflected light from the light coloured walls, tabletops (rose colour plastic, matte finish), window wall, and the nearby glazed door of the beauty salon would have also contributed the high light level seen here.

Other task areas had too little light. Lighting available for the shuffleboard table in the horticulture room at MPN changed from a level suitable for games during the day (>500 lux) to no longer suitable at night (382). The shuffleboard at MPW was located in a side passageway of the great room where light was similar for day and nighttime measurements; however, readings of 216 (day) and 227 (night) lux indicated the light was not sufficient to meet IESNA's recommended 500 lux. The activity convenor said that MPW residents did not use the shuffleboard either during the day or the evening.

4.1.3.1 Common Area Summary

At MPN the daytime averages for task lighting met or exceeded IESNA minimum recommendations in four common rooms. Three did not, and three areas had ranges where the maximum met the recommended level, but the minimum did not (Table 4). The music room was not included in this tally because there is no corresponding room at MPW, nor were the television areas because IESNA has no recommendations on such areas. In the corresponding tally at MPN for nighttime measures there were no areas meeting or exceeding IESNA recommendations, seven had inadequate lighting, and four spanned the recommendations.

At MPW, daytime averages, or ranges, for only two common areas met or exceeded the recommendations, six did not, and two areas had ranges that spanned the recommendations. The tally was the same at night, although generally readings were lower.

4.1.3.2 The Houses

Although much of the task lighting in the common areas at both MPN and MPW fell short of the IESNA minimum recommendations, the task lighting in the residential wings was a little better. In most rooms at MPW it appeared that one could find an area that was lit to the recommended level.

Table 4

Task Lighting for Daytime and Nighttime in McConnell Place North and McConnell Place West

All measurements in lux

	McConnell Place North		McConnell Place West		IESNA
	Daytime	Nighttime	Daytime	Nighttime	Minimum
Common Rooms					
Great Room (chairs for games & bingo)	781 – 1218 (range for chairs)	56-65 (range for chairs)	269 – 377 (range for chairs)	204 – 308 (range for chairs)	500‡ 750‡
(piano & organ* music rest)	943	50	228, 304*	169, 245	750
(shuffleboard table)	–	–	216	227	500
Front Street Hall (reading chairs)	418 – 440	90 – 98	326 – 361	187 – 212	750
Back Patio Hall (bistro tables – cards)	32 500	399	651	580	750
Green Area Hall (reading chairs)	516 – 523	389 – 401	195 – 656	302 – 381	750
Rose Area Hall (reading chairs)	532 – 586	347 – 354	428	403	750
Library Seating (reading chairs)	159 – 784	68 – 289	527 – 770	421 – 789	750
Family Dining Room (kitchen)	238 – 1395	257 – 1800	359 – 1550	267 – 1017	500
(dining table)	331 (average)	302 (average)	629 (average)	536 (average)	500
Entertainment Room (TV)	175	81	426	370	–
TV area (TV)	308	321	377	369	–
Horticulture Area (counter)	743 (average)	666 (average)	444	446	500
(shuffleboard table)	789	382 (average)	–	–	500
Craft Room (table)	844	800	604	No change**	500
(counter)	195 (average)	172 (average)			500
(sink)	383	371	–	–	500
Beauty Salon (counter)	688	618	733	802	500
(sink)	671	468	534	599	500
Music Room (organ music rest)	124	88	–	–	750
Shared Spaces					
Green House					
Living-Dining Room (reading chairs)	105 – 107	40 – 56	308 – 1375	198 – 600	750
(dining table – crafts)	121 – 180	71 – 111	586 – 842	504 – 684	500
(TV)	76	56	529	260	–
Kitchen	160 – 1092	114 – 1252	371 – 1321	384 – 1292	500

	McConnell Place North		McConnell Place West		IESNA
	Daytime	Nighttime	Daytime	Nighttime	Minimum
Laundry	1117 – 1539	No change**	627 – 1196	617 – 1308	500
Tubroom (mirror above sink)	778	778	1041	1196	600†
Rose House					
Living-Dining Room (reading chairs)	122 – 221	49 - 64	362 – 754	385 – 777	750
(dining table – crafts)	132 – 188	74 - 105	642– 700	638 – 686	500
(TV)	86	44	225	242	–
Kitchen	166 – 1038	139 – 1158	356 – 1456	386 – 1385	500
Laundry	643 – 1206	No change**	667 – 1585	542 – 1578	500
Tubroom (mirror above sink)	773	773	1089	970	600†
Blue House					
Living-Dining Room (reading chairs)	–	–	427 – 433	400 – 421	750
(dining table – crafts)	162 – 207	50 – 125	574 – 736	562 – 681	500
Kitchen	306 –37600	162 – 1248	442 – 1460	343 – 1450	500
Laundry	934 – 1308	No change**	570 – 1305	385 – 1802	500
Tubroom (mirror above sink)	784	784	1131	1039	600†
Private Rooms					
Bedroom (Staff-rated darkest bedroom)					
(reading chair)	107	51	62 and 290	41 and 63	750
(bed)	222	51	134	68	500
(desk/ table)	319	222	631	435	750
Ensuite Bathroom (mirror above sink)	730	837	1188	1014	600†
Bedroom (Staff-rated brightest bedroom)					
(reading chair)	–	–	92	35	750
(bed)	1360	63	333	41	500
(desk /table)	766	40	–	36	750
Ensuite Bathroom (mirror above sink)	919	852	1214	994	600†

‡ 500 lux recommended for task lighting in all active areas, 750 lux for task lighting in Living Rooms.

† For makeup/shaving area.

** Measurements were not taken at night in windowless rooms that admitted no exterior light. Trial measures were taken in one laundry to ensure measurements were not more than a few lux different than daytime.

In the houses, in the daytime, only the laundries and tubrooms had areas where task lighting consistently met the minimum IESNA recommendations. In each kitchen at both MPN and MPW, there were areas well below the recommended level and areas well above it. Most of the task lighting measurements[8] for MPW's kitchens were well above the recommended level of 500 lux. For both day and night measurements, the lowest light level was at the sinks, the counter by the refrigerator, and the stove. Areas well above the recommended level included the counter where the telephone was located, as well as the island used for meal preparation. There was greater variability in measurements at MPN. With the exception of the Blue kitchen, which received the most direct sunlight, the majority of readings were lower than the recommended level. Problem areas in each kitchen included the stove area, as well as a counter where the telephone was situated. Nighttime levels dropped for each kitchen, with the Blue kitchen changing remarkably from a range of 306-37 600 lux to 162-1248 lux (Table 4).

At MPN, the living-dining rooms' lighting of all houses was below recommended minimums in every area measured, whereas at MPW the task lighting at the tables in all three houses met IESNA recommendations. At MPW, some reading chairs in these rooms had enough light and some did not in both the Green and Rose houses; however, the reading chairs in Blue house did not have sufficient light.

Nighttime measures were much the same at MPW within the same rooms. MPW had six nighttime measures that spanned the recommendations (i.e., the maximum met the recommendations, but the minimum did not). At MPN, there were three areas that spanned the recommendations. MPW had five measures that met the recommendations and six that spanned the recommendations. The bedrooms were all poorly lit except the Blue house bedroom at MPN in daytime, where the sunlight boosted the measurement. In general, task lighting (Table 4) appeared to be poorer than ambient lighting in many areas (Table 2).

Daytime measurements in both of the bedrooms expected to be darkest (in the Green house at MPN and MPW) revealed insufficient lighting for reading text. Nighttime measurements were lower. Similarly, daytime measurements in the bedrooms expected to be brightest indicated that task lighting was insufficient in MPW's Blue house. However, measurements in the parallel MPN bedroom, which had strong sunlight coming in the window, exceeded recommended levels at the bed, with 1360 lux, and table, with 766 lux. Light dropped dramatically after the sun went down. At night there was only 63 and 40 lux, respectively, available in these two spots.

4.1.4 Lighting at Face Height

Relatively low measurements were recorded in halls, particularly in MPN (Table 2 and Table 3). They were so low that face recognition might be a problem considering the age of residents. Residents should not only be able to see where they are walking, but they should be able to have enough light to distinguish faces. Consequently, a series of measurements were taken at face level throughout the halls of both centres. Although the measurements were compared with IESNA's minimum recommendations for ambient light, the new age-adjusted standards do not include recommendations specific to face level lighting, and the 300 lux recommended for ambient light in halls may be low. A design professional who works with aged populations has

[8] Based on measurements at many key points in the rooms (not tabled).

recommended 500-1000 lux to ensure facial recognition among nursing home residents (Hiatt 1991).

4.1.4.1 Common Areas

Table 5 indicates that the daytime minimum measurements at face level in the common area halls at both centres were consistently lower than the minimum measurements taken at floor level (Table 2). Of the minimum measurements at MPN, only the back patio hall was above the recommended level. None of the MPW face level minimums were above the IESNA recommended minimum.

4.1.4.2 The Houses

Lighting in the halls within the houses was also low. The daytime face level minimum measurements at MPN were even lower in the bedroom halls than the measurements taken at floor level (Table 3). In contrast, at MPW the daytime minimums at face level were higher than floor level measurements in two halls, and lower in one, the Green bedroom hall. The face level minimum in the MPW Blue bedroom hall exceeded the IESNA recommended 300 lux minimum. At MPN all bedroom halls were far below 300 lux.

The lighting in bedroom halls at MPW was provided by downlights, which direct the light down rather than diffusing it. Bedroom hall lighting at MPN was designed to ensure the floors were lit between light sources. At MPW, the design goal was to increase the amount of light throughout. Consequently, the combinations of light fixtures in the bedroom halls of the two centres were very different. MPN had seven wall sconces and six ceiling mounted fixtures. MPW had 15 recessed downlights plus a large central hanging fixture, which was set in a vaulted ceiling. It diffused light differently than the downlights, affecting the readings at adjacent downlights.

Table 5

Ambient Light in Halls in McConnell Place North and McConnell Place West at Face Level

Measurements were taken 5'8" from the floor. They are reported in lux.

	MEDIAN Daytime		MAXIMUM Daytime		MINIMUM Daytime		IESNA Minimum
Common Areas	**MPN**	**MPW**	**MPN**	**MPW**	**MPN**	**MPW**	
Front Street Hall	392	235	764	407	120	135	300
Back Patio Hall	2565	635	3038	750	1017	210	1000†
Rose Area Hall	119	471	181	617	98	68	300
Green Area Hall	232	261	279	422	151	198	300
Houses							
Green Bedroom Hall	91	1193	360	2042	20	124	300†
Rose Bedroom Hall	119	1074	336	2239	38	278	300†
Blue Bedroom Hall	102	948	336	2478	30	320	300†
	Nighttime		**Nighttime**		**Nighttime**		
Common Area	**MPN**	**MPW**	**MPN**	**MPW**	**MPN**	**MPW**	
Front Street Hall	176	237	601	489	11	57	300*
Back Patio Hall	67	651	73	873	60	129	300*
Rose Area Hall	59	302	60	449	52	67	300*
Green Area Hall	59	302	634	350	39	155	300*
Houses							
Green Bedroom Hall	103	1022	326	1854	7	120	300*
Rose Bedroom Hall	87	989	322	1969	19	371	300*
Blue Bedroom Hall	81	886	357	1123	19	350	300*

* Residents were still active. The recommended level for halls is 100 lux during sleeping hours.

† Because of direct outdoor access, 1000 lux is recommended inside the door in daylight, 100 lux during the night, but not throughout the hall.

4.1.5 IESNA Minimum Recommendations for Interior Entries

In a number of areas discussed above, residents could be expected to have some difficulty adapting to changes in light levels, particularly the large changes evident when they passed back and forth from interior areas to the outdoors. Transition areas are important to the aged because their eyes take longer to accommodate to light changes. This is the rationale for the IESNA recommendation of 1000 lux minimum for an interior entry in daytime and 100 lux minimum for the entry at nighttime. Such levels would provide transition areas.

4.1.5.1 Courtyard Doors in the Common Areas

One problematic area appeared to be the back patio hall because, in both centres, the hall had a door with direct access to the patio, courtyard, and garden areas. The daytime IESNA recommendation of 1000 lux was cited in Table 2 for this hall; the nighttime recommendation was not considered relevant because the back patio hall was also a route to the great room, and residents were still active at night and using the hall, but were not apt to use the patio exit.

At MPN, the back patio hall ran along the south side of the building, and no awning or roof protected either the window wall or the door to the patio. It was strongly lit by sunlight throughout the middle of the day. No transition area allowed residents' eyes to adapt to the differences in light intensity. Measurements for task lighting (Table 4) revealed a reading of 32 500 lux at the bistro tables in the back patio hall at MPN, which, as reported above, was even higher than the exterior reading at the window wall along this hall (11 700 lux, Table 1).

The back patio hall at MPW ran along the west side of the centre, and a roof overhang extended 10.5 feet from the building all along the west wall, shading both the exterior doorway and window wall. This improved design was precipitated by the high light levels in this location at MPN (MPW was built after MPN), but the MPW hall, with a median reading of only 450 lux, did not appear to be a good transitional area either. However, the exterior of the window in this hall measured only 382 lux, suggesting that the roof overhang provided residents a satisfactory transition area. A measurement of 1999 lux at an unshaded part of the exterior back wall provided evidence that the roof overhang was doing its job (untabled data).

The main entrance presented no lighting adaptation problems at either centre; visitors entered resident areas through the front street hall, after passing through vestibules and entries (glass porches) which served as transition areas. Three other outdoor exits from the common rooms, in both centres, did not appear to require 1000 lux at the interior entries because of roofed patio areas immediately outside them, like the entrances at the back patio hall at MPW. The large number of doors from the residents' portion of the centres were part of the "wandering pathways" that are a feature of well-designed Alzheimer care centres. All doors led to patios and courtyard areas in the secured yard, which were linked by cement paths that led back to the doors.

4.1.5.2 Courtyard Doors in The Houses

Each house at MPN had two doors to the exterior. A door led from each living-dining room to a roofed patio, which appeared to serve as a transition area. These living-dining room doors were not included in the design of MPW; it had only one door to the exterior in each house. Thus the houses in both centres had doors at the end of each bedroom hall to provide access to the courtyards. These doors opened onto very small patios with very abbreviated roofs, and therefore appeared to provide little or no transition area. These doors, although essential both to the interior floorplan[9] and to the wandering pathway system, were associated with another lighting issue.

At MPW an unexpected dark spot was found in the bedroom hall of all houses. The halls had a short hall, like the crosspiece to a capital letter T at the end furthest from the kitchen (Figures 1 and 2). For lighting purposes this area likely should have been distinguished from the rest of the Bedroom Hall. In Table 3, for example, an IESNA recommendation of 300 lux is associated with the Bedroom Halls because of its primary use; however, because the T section of the hall contained a door to the courtyard, that section of Hall required 1000 lux during the day, and 100 lux at night (see Table 3, footnote). In MPW this short piece of hall had two recessed downlights located so that one highlighted a quilt on the end wall, and the second was near the exterior door. The spacing resulted in a resident's door (one of two leading to the semi-private bedroom) having very low readings at both floor and face levels. The other door to the same bedroom benefited from a small light that illuminated the linen closet opposite the bedroom door. At face level during the day, the MPW Green bedroom hall had 2042 lux under the light near the exterior door (Table 5) and 35 lux at the first semi-private bedroom door. In the Rose house and Blue house, respectively, measurements under the exterior door light were 2239 and 2478 lux, and 40 and 31 lux by the bedroom door (untabled bedroom door measurements). These dark spots surprised the lighting technician taking measurements. They may have resulted from a design or installation flaw.

Anyone entering the MPW bedroom halls from the exterior door would have, at face level, the minimum 1000 lux recommended for interior entries during the daytime (IESNA 1998). However, the next step or two would plunge the person into relative gloom, because the ambient light levels were low in all bedroom halls and did not meet the 300 lux recommended (Table 3). Moreover, a resident standing in the first door to the semi-private bedroom watching another enter the hall from outdoors would likely see only the outline of a person against the backlit glass door. There would not be enough light at that point for facial recognition because of veiling luminance.

At MPN, most of this T section of the bedroom hall had low lighting, like the rest of the bedroom hall (daytime minimums ranged from 36-51 lux at floor level; Table 3). The maximum ambient light in each bedroom hall occurred in this T section beneath a ceiling fixture at the door to the courtyard. Even the maximums, which ranged from 511 lux in the Blue house to 543 lux in the Green house, were well below the 1000 lux recommended for an interior entry in daytime. Like MPW, MPN had poor transition areas between the bright light of the outdoors and the

[9] Good design for Alzheimer centres dictates that halls should not have a dead end. The exterior door, with its glass panel, provided a view outdoors and, if the residents chose, a place to go.

comparatively dull light of indoors (floor level measurements inside the doors ranged from 393 to 486). A person going inside or outside would be temporarily blinded by the change in light.

The lack of adequate transition areas in the bedroom halls at both centres, and the darkness of the halls at MPN, suggested these locations had lighting levels that might put residents at risk of falls; however, from other perspectives good design made these low-risk areas. Handrails, coloured to contrast with the walls, were placed along one wall of the bedroom halls, although the handrails were broken by doorways.[10] In addition, there was a smooth transition at floor level between the bedroom hall and the outdoors. There were no level differences that might trip a resident, except a low doorsill. These courtyard doors opened onto a cement pad that was at the same level as the floor inside (which was true of all courtyard doors). Moreover, the cement pad for the porch and the walkway leading from it were at exactly the same level.

4.1.6 Summary of Results for Ambient, Task, and Face Level Lighting

In summary, transition areas, task lighting, and face level lighting were the main lighting issues that arose through objective measurement of resident areas in the two centres. However, IESNA minimum recommendations were not met in many locations. Based on a comparison of minimum daytime measurements for ambient lighting and IESNA minimum recommendations for ambient lighting, the library seating area, music room, and Rose area hall in MPN common areas had inadequate daytime lighting (Table 2). In the MPN houses, the rooms inadequately lit were the living-dining rooms and bedroom halls in all three houses, the Rose kitchen, and the bedroom in the Green house that was measured (Table 3).

Based on the same comparison, in the common areas of MPW, there was inadequate daytime lighting only in the back patio hall (Table 2), and, as discussed above, it is likely appropriate to have less than the IESNA recommendation of 1000 lux in this hall. In the houses, the inadequately lit rooms were the bedroom halls in all three houses, as well as both the Green house bedroom and Blue house bedroom that were measured (Table 3).

Based on the minimum nighttime measurements and IESNA minimum recommendations for areas where residents were active, the following common areas in MPN had inadequate nighttime lighting: beauty salon, great room, library seating area, music room, front street hall, back patio hall, Green area hall, and Rose area hall. In fact, only two areas had lighting that met IESNA recommendations, the craft room and the horticulture room (Table 2). In the houses, only the Blue kitchen met IESNA recommendations. The inadequately lit areas were the living-dining rooms and bedroom halls in all three houses, the Green kitchen, Rose kitchen, as well as the Blue house bedroom and Green house bedroom (Table 3).

Based on the same comparison, MPW had inadequate nighttime lighting, in the common areas, in the great room, front street hall, and Rose area hall, and in the houses, in all three bedroom halls, as well as both the Blue house bedroom and Green house bedroom that were measured.

The remarkable differences between day and night measurements, particularly at MPN, suggested that the centres made good use of daylighting, that is the gathering of direct and

[10] At MPW the handrail was on the left side only, at MPN it was on the right side only.

reflected natural light deep into the building. This was likely more effective at MPN because of an unprotected south-facing window wall that exposed the central part of the building to bright light. Thus, the orientation of MPN and MPW was a factor in the results. Very likely measured differences between similar rooms in the two settings were attributable to natural daylighting and higher light intensity at MPW, considering that the physical attributes of the space (such as differences in colour of walls and rugs, etc.) were highly similar.

Measures of task lighting in the common areas indicated residents would have difficulty in either centre in finding an easy chair where the recommended minimum lighting level for reading text was available. Three out of four areas with easy chairs had inadequate reading levels (Table 4). In addition, at MPN, task lighting for other activities was inadequate day and night. For example, at night the sink in the beauty salon, as well as the bistro tables, shuffleboard, piano, and organ had inadequate task lighting. Even the sink in the otherwise well-lit MPN craft room had inadequate lighting. In MPN, the dining tables in all the houses' living-dining rooms had inadequate lighting for crafts (or reading), day and night, and both the Green house and Blue house bedrooms that were measured had locations or times when there was inadequate task lighting for crafts.

At MPW, task lighting was inadequate, day and night, in common areas: for the piano and organ, shuffleboard, bistro tables, and horticulture counter. In the MPW houses, lighting was inadequate, day and night, for tasks done in bed in both bedrooms measured, as well as on a table in the Green house bedroom. The lighting was not adequate for crafts or reading in the chair in either bedroom.

Task level measurements uncovered dark spots and bright spots within rooms. The contrast between task lighting and ambient lighting was remarkable in some rooms. For example, overhead fluorescent panel lighting in the craft room at MPN delivered good lighting to a central table, and provided good ambient lighting, but the countertops had poor task lighting. The contrast between lighting at the midpoint and perimeter was evident in resident bedrooms. Where measurements were taken at room midpoint, readings were higher than other parts of the room, where desks, chairs, and beds were located. Additional table and floor-standing fixtures were required for task lighting at the bed, easy chair, desk, or table. Family members and residents arranging the rooms may have been more concerned with esthetics than lighting, or they may not have realized the level of lighting required by the aged for tasks. Because residents frequently go through their purses, dresser drawers and photo albums, the lack of task lighting in their bedrooms is a problem, in the same way that poor ambient lighting appeared to present problems in other areas.

At face level, the only minimum daytime measurements in halls that met IESNA minimum recommendations for ambient light were the MPN back patio hall and the MPW Blue bedroom hall. Nighttime minimum measurements at the MPW Rose bedroom hall and Blue bedroom hall met IESNA minimum recommendations for residents' active periods (Table 5). The IESNA minimum recommendation of 300 for ambient light in halls was used because no recommendation was made for face level lighting. As mentioned above, a design expert familiar with environments for the aged has recommended 500-1000 lux for face level lighting (Hiatt

1991). If such levels were used in halls, objections may arise from design professional trying to maintain a residential appearance.

Hall lighting raises another similar design issue. The variation in the measurements taken along the length of the halls revealed that the lighting was uneven on the horizontal plane. The variations noted between face level and floor level indicated the lighting in the halls was also uneven on the vertical plane. Although such variation is considered relaxing by lighting experts who recommend non-uniform lighting (IESNA 1993, p. 99-100), this runs against the advice of other experts who suggest uniform lighting for persons with Alzheimer's disease (e.g., Brawley 1997). Because no age range is cited for the observer preference studies on which IESNA bases its recommendation for non-uniform lighting, this psychological consideration has likely not been tested with the aged. Studies involving aged participants should be cited if such recommendations are to be extended to their age cohort. Uniform lighting will appear to be more institutional, and non-uniform more residential, again making choices difficult for design professionals.

4.2 Survey of Staff and Residents' Family Members

4.2.1 Staff Participants

A survey of staff and residents' family members provided a subjective assessment of the adequacy of lighting in the two centres. They were asked to indicate where in the centres residents would engage in 16 different activities, the time of day this would occur, the duration of the activity, and to rate whether the lighting was adequate or inadequate from the residents' perspective (Appendix I). In addition, they were invited to add comments. Information was also requested about the respondent, including gender, use of glasses, and whether he or she had visual problems.

Forty-three staff members provided responses to the survey, a response rate of 67%. There was no significant difference in the number or characteristics of staff responding from the two centres (21 from MPN and 22 from MPW). The overwhelmingly majority was female (95%) at both centres. The largest age group at both centres was under 40 (45% at MPN, 59% at MPW), with the next largest group aged 40-50 (35% at MPN and 36% at MPW). A few were older than 50 (20% at MPN and 5% at MPW).

There were no significant differences between the staff at the two centres with regard to the following variables:

- Whether glasses were needed to read (52% needed them at MPN and 43% at MPW; 21 responded to the item at each centre).
- Whether glasses were needed to drive (57% needed them at MPN and 40% at MPW; 21 responded at MPN and 20 at MPW).
- Limited night vision (29% said yes of the 7 responding at MPN, and 22% of the 9 responding at MPW).
- Whether glaucoma was present (0% said yes for the 5 responding to the item at MPN, and the 7 responding at MPW).

- Whether cataracts were present (20% said yes for the 5 responding to the item at MPN, and 0% of the 7 responding at MPW).
- Other vision problems reported were nearsightedness and astigmatism (86% of the 7 responding to the item at MPN, and 100% of the 4 responding at MPW).

There were no significant differences in their satisfaction with the light levels between the groups with and without vision problems. Discussion with the managers of the two centres about the low numbers of staff responding to some items relating to their vision suggested that those without the specific visual problems likely omitted items they felt were not relevant. The majority of staff at both centres did not know their uncorrected or corrected vision rating. Of the handful that could provide specific information, only one from each centre, of the nine reporting from MPN and the eight from MPW, said their corrected vision was anything other than 20/20 (at MPN one said -7.75/8.25 and at MPW one said 2.5/2.5). One staff member at MPN reported uncorrected vision of -9.75/-9.75, whereas at MPW three reported 20/20 and one 3.5/3. [11]

4.2.2 Staff Ratings of the Lighting

The items on the survey form were intended to identify areas where lighting presented a problem with respect to particular activities. Staff ratings of the adequacy of lighting were remarkably different at the two centres. Of the 16 activities included in the survey, ratings at the centres were significantly different for 12 (χ^2, $p = <.05$, Table 6); and using less stringent criteria, ($p = <.10$), 14 were significant. Staff satisfaction with lighting was significantly less at MPN for all activities except grooming and medical treatments. For medical treatments, staff at both centres rated the lighting as unsatisfactory.

Table 6 indicates the number of staff who provided information related to each of the 16 activities. The majority of the staff responded to most questions; however, the woodworking item received very few responses, perhaps because few staff members have been involved with residents who did woodworking.

MPN staff were not 100% satisfied with lighting for any of the 16 activities. MPW staff gave 100% endorsement to lighting for all but six activities. Satisfaction with lighting for a particular task is not very informative unless one knows the area where the task was performed and what lighting was available. Table 6 contains this information, as well as the levels of satisfaction.

[11] Corrected vision ratings are measured in diopters, a prescriptive measure for such problems as myopia and astigmatism. A diopter measures the refractive power of a lens. The further away the stated number is from 0, the greater the correction in vision (American Eye Institute 1999, Website). Perfect vision is 20/15.

Table 6

Differences in Staff Satisfaction at McConnell Place North and McConnell Place West with Lighting for Specific Resident Activities, The Use of Rooms for Activities, and Actual Task Lighting in the Rooms*

Activity†	MPN Percent Satisfaction (No. raters)	MPW Percent Satisfaction (No. raters)	X^2 P Value (N)	MPN Rooms Used, Hours & Duration	MPN Day/Night Task Light in lux	MPW Rooms Used, Hours & Duration	MPW Day/Night Task Light (lux)
Arts & Crafts (500 lux recommended)	50.0 (14)	100 (13)	.003 (27)	Living-Dining Room, Craft Room, (1-8 p.m., 45 min-1 hr 30 min)	D=50-207 C=172-844	Living-Dining Room, Great Room (8 am-p.m., 45 min-1 hr)	D=504-842 G=204-377
Table Games (500 lux recommended)	64.7 (17)	100 (16)	.009 (33)	Living-Dining Room, Horticulture, Great Room (1-8 p.m., 45 min-1 hr 30 min)	D=50-207 H=666-743 G=56-1218	Living-Dining Room, Kitchen, Great Room (1-8 p.m., 45 min-1 hr)	D=504-842 K=343-1460 G=204-377
Chores (500 lux recommended for kitchen tasks)	38.9 (18)	73.7 (19)	.033 (37)	Living-Dining Room, Kitchen, Laundry, Bedrooms, etc. (8 am-8 p.m., 15 min-8 hrs)	D=50-207 K=114-37600 La=643-1539 B=40-1360	Living-Dining Room, Kitchen, Laundry, Bedrooms (8 am-8 p.m., 20 min-7 hrs)	D=504-842 K=343-1460 La=385-1802 B=35-631
Clerical Tasks – Writing (750 lux recommended for living room tasks)	42.9 (14)	92.3 (13)	.006 (27)	Living-Dining Room, Kitchen, Laundry (8 am-8 p.m., 10 min-1 hr 30 min)	D=40-221‡ K=114-37600 La=643-1539	Living-Dining Room, Kitchen, Laundry (8 am-8 p.m., 5 min-1 hr)	D=198-1375‡ K=343-1460 La=385-1802
Cooking & Baking (500 lux recommended)	52.6 (19)	100 (19)	.001 (38)	Kitchen (8 am-8 p.m., 30 min-4 hr)	K=114-37600	Kitchen, Living-Dining Room (8 am-8 p.m., 30 min-2 hr)	K=343-1460 D=504-842
Dancing (300 lux recommended for walking)	63.2 (19)	100 (17)	.005 (36)	Great Room (1-8 p.m., 30 min-2 hr)	G=56-1218	Great Room (1-8 p.m., 1hr-1 hr 30 min)	G=204-377
Eating (500 lux recommended)	47.6 (21)	100 (19)	.000 (40)	Living-Dining Room, Kitchen (8 am-8 p.m., 30 min-10 hrs)	D=50-207 K=114-37600	Living-Dining Room, Kitchen (8 am-8 p.m., 30 min- 2 hrs)	D=504-842 K=343-1460
Exercise (300 lux recommended)	58.8 (17)	100 (13)	.008 (30)	Great Room (8 am-8 p.m., 15 min-1 hr)	G=56-1218	Great Room (8 am-8 p.m., 15 min – 2 hrs)	G=204-377
Group Activities (300 lux recommended)	57.9 (19)	100 (18)	.002 (37)	Family Dining Room, Great Room, Library, Living-Dining Room, Kitchen (8 am-8 p.m., 30 min-2 hrs)	F=302-331 G=56-1218 Li=68-784 D=50-207 K=114-37600	Great Room, Entertainment Rm/ TV area, Living-Dining Room, Kitchen (8 am-8 p.m., 30 min- 2 hrs)	G=204-377 E=614-662 D=504-842 K=343-1460

Activity[†]	MPN Percent Satisfaction (No. raters)	MPW Percent Satisfaction (No. raters)	X^2 P Value (N)	MPN Rooms Used, Hours & Duration	MPN Day/Night Task Light in lux	MPW Rooms Used, Hours & Duration	MPW Day/Night Task Light (lux)
Music (500 lux recommended)	61.1 (18)	100 (16)	.005 (34)	Great Room, Living-Dining Room, Library (8 am-8 p.m., 30 min-4 hr)	G=56-1218 D=50-207 Li=68-784	Great Room, Kitchen (8 am-8 p.m., 30 min-2 hr)	G=204-377 K=343-1460
Playing Cards (750 lux recommended for living room tasks)	50.0 (18)	100 (16)	.001 (34)	Living-Dining Room, Great Rm, Library (8 am-9:30 p.m., 30 min-2 hrs)	D=50-207 G=56-1218 Li=68-784	Living-Dining Room, Kitchen (1-8 p.m., 30 min-1 hr)	D=504-842 K=343-1460
Reading (750 lux recommended for living room tasks)	35.7 (14)	76.9 (13)	.031 (27)	Living-Dining Room, Library, Kitchen, Common Area Halls, Great Room (8 am-8 p.m., 15 min-10 hrs)	D=40-114[§] Li=68-784 K=114-37600 Ha=90-32500[§] G=56-1218	Living-Dining Room, Bedroom, Common Area Halls, Entertainment Room (8 am-11 p.m., 15 min-1 hr 30 min)	D=198-1375[§] B=35-631 Ha=187-656 E=614-662
Walks (300 lux recommended)	75.0 (16)	94.7 (19)	.096 (35)	Inside, Outside, Common Areas (8 am- 8 p.m., 15 min-10 hrs)	All halls =64-31620	Inside, Outside, Common Areas, Main Hall (8 am-8 p.m., 5 min-3 hrs)	All halls =200-726
Woodworking (500 lux recommended)	50.0 (6)	100 (4)	.091 (10)	Craft Room (1-8 p.m., 1-2 hrs)	C=172-844	Great Room, Craft Room (1-8 p.m.. 30 min-1 hr)	G=204-377 C=604
Grooming[‡] (600 lux recommended)	82.4 (17)	64.7 (17)	.244 (34)	Bedroom, Ensuite Bathroom (8 am-8 p.m., 10 min-4 hrs)	B=40-1360 Ba=730-919	Bedroom, Ensuite Bathroom, Living-Dining Room, Beauty Salon (8 am-8 p.m., 10 min-3 hrs)	B=36-631 Ba=994-1214 D=504-842 Be=534-302

Medical Treatments†† (1000 lux recommended)	38.5 (13)	46.2 (13)	.691 (26)	Bedroom, Living-Dining Room, Medication Room, Kitchen (8 am-8 p.m., 10 min-1 hr)	B=40-1360 D=50-207 K=114-37600 M=not measured	Bedroom, Medication Room (8 am-8 p.m., 20 min-1hr)	B=35-631 M= Not measured

* Daytime to nighttime ranges of lighting are almost all compiled from task lighting measurements in Table 2. If each house had the room specified by staff, then the lighting range is across the rooms of all houses. Light range for "Walking" is ambient hall lighting (Table 2, Table 3). Light range for group activities in the Entertainment Room is ambient light (Tabie 2)

† IESNA recommendations are for minimum task lighting.

§ Lighting range is for reading chairs.

‡ Grooming occurred primarily in the residents' bedrooms and ensuite bathrooms.

†† Two-thirds to three-quarters of staff said they primarily used residents' bedrooms for this.

The house living-dining rooms at both MPN and MPW were evidently multi-purpose rooms, being used for 10 of the 16 activities. This was likely due to the nature of the care program rather than satisfaction with lighting, at least in MPN, because 50% of MPN staff said they were dissatisfied with lighting in that location for activities like playing cards and arts and crafts. Staff members' tasks and the need to oversee residents found in the living-dining rooms likely resulted in heavier use of those rooms than rooms in the common area. The MPN craft room was used for only two activities, staff said, and the MPN horticulture room for only one, although both spaces had better task lighting than most areas in that centre. The MPW craft room was only used for woodworking.

In general, staff ratings of the adequacy of the lighting for various tasks corresponded relatively well with the objective measurements of lighting levels, which were too low for most of the 16 tasks in the survey (Table 6). The format of the questions on the survey did not allow discrete comparisons of objective measures of lighting levels with the staff members' satisfaction or dissatisfaction with levels. Staff typically reported that residents read, for example, in several locations, and then rated the lighting as inadequate for that activity. But in another item of the survey form they indicated many of the same locations were used for another activity, and lighting was then rated adequate. A substantial percentage (40-60%) of staff members at MPN were unhappy with the lighting available for most tasks, but they were most unhappy with lighting for chores, reading and medical treatments. MPW staff were relatively happy with lighting levels, even though minimum nighttime light levels in some key areas such as the sinks, stove, and the counter by the refrigerator at night were below IESNA minimum recommendations. Presumably, they could find lighting at the higher end of the range for their tasks in these rooms. Interestingly, of the activities for which lighting was judged inadequate at MPW, four types occurred in the resident bedrooms (but not only there). However, no other activities occurred in the bedrooms, suggesting bedrooms were viewed as a problem area. This was supported by the only written comment from staff at MPW, "Resident rooms have very poor lighting, not bright enough."

In contrast with the single comment added by MPW staff, MPN staff members added a number of criticisms that addressed several lighting issues. The MPN comments were:

- At nighttime, the halls are too bright. Staff need to be able to adjust the lighting more.
- Hall lights too bright at night.
- Great room lights too dim on dull days and evenings.
- Study needs to include time of year and weather conditions because of the sunlight in the summer. When sunlight is shining, great room and house kitchens are lighted better, but in winter when the sun goes down, for supper and the activities, it is too dark.
- Craft room, horticulture room, and staff room are the only rooms that are bright enough when the sun is down.
- The activity times on the survey are not relevant (from one night staff).

Although the number of staff who reported they had specific visual problems was always small, analyses suggest staff members' own vision sometimes affected their rating of lighting. The differences reported below appear to be associated with visual problems, not with age, because overall there was no significant difference between the age of the staff at MPN and MPW, even

though MPN had more older staff (20%) than MPW (5%). The only visual problem associated with age was cataracts (Pearson $r = .581$).

- There was no significant difference in the satisfaction ratings between staff who required glasses to read and those who did not at either MPN or MPW.

- The 12 staff at MPN who needed glasses to drive had significantly different ratings of lighting for some activities, compared to the nine who did not need glasses to drive. More of those needing glasses to drive at MPN said lighting was inadequate for music (χ^2 (1, N = 18) = 4.22, $p < .040$), and walking (χ^2 (1, N = 16) = 5.33, $p < .021$). In addition, using less stringent criteria for significance (the .10 level), more needing glasses to drive said lighting was inadequate for cooking (χ^2 (1, N = 14) = 2.43, $p < .091$), dancing (χ^2 (1, N = 19) = 3.52, $p < .061$), exercise (χ^2 (1, N = 17) = 3.55, $p < .059$), and group activity (χ^2 (1, N = 19) = 2.77, $p < .096$). The effect was not seen at MPW. At MPW, the need of nine staff for glasses to drive did not significantly affect their rating of lighting, compared with the 12 not needing glasses.

- The two staff at MPN who said they had limited night vision rated lighting for dancing (χ^2 (1, N = 7) = 2.92, $p < .088$) and eating (χ^2 (1, N = 7) = 3.73, $p < .053$) significantly worse (at the .10 level) than the five who reported no such problem. The effect was not seen at MPW. At MPW, the two staff who said they had limited night vision had ratings that were not different from seven staff without this problem.

- At MPN, one staff member said she had cataracts and four said they did not. Based on these five responses, the following activities were rated significantly different: exercise (χ^2 (1, N = 5) = 5.00, $p < .025$), group activities (χ^2 (1, N = 5) = 5.00, $p < .025$), and music (χ^2 (1, N = 5) = 5.00, $p < .025$), with the staff member with cataracts indicating lighting was inadequate. No staff at MPW reported cataracts.

- No significant differences in satisfaction with the light levels were found for the groups with and without other vision problems (nearsightedness and astigmatism).

Thus, having limited night vision, needing glasses to drive, and having cataracts affected staff ratings, but only at MPN. Staff with these visual problems were more apt to view the lighting negatively compared to other staff; that is, these staff members' ratings of the adequacy of lighting was more consistent with the results from the objective measurements of light levels. Very likely the effect was not seen at MPW, because approval ratings were high and objective measurements suggested there was less to criticize there. MPN, as discussed above, showed greater variation within rooms between maximum and minimum measurements than MPW. There was also more change from daytime to nighttime.

4.2.3 Family Participants

The return rate for the 72 lighting surveys mailed to family members at both centres was 47% (17 replies) at MPW and 31% (11 replies) at MPN. The rate of return was significantly different at the two centres (χ^2 (1, $\underline{N}$ = 36) = 17.70, $\underline{p}$ <.000). The centre managers suggested that the relatively new MPW was still in a "honeymoon" phase of operation, and that may have accounted for the difference in response rate from families associated with the two centres. Of the 28 forms returned by family members, three (11%) were discarded because the respondents provided only their names, resulting in 25 valid forms used in the analysis. Table 7 indicates the number of family members who provided information related to each of the 16 activities. Most respondents omitted responses for many activities. Thus Table 7 may not adequately represent family members associated with the centres, but suggests the direction that could be expected if more had completed the forms.

No significant differences were found between the family members at MPN and MPW in either age or gender. The majority of respondents were women (64%). At MPW, where 15 responded to the question asking their age range, the majority were between 50-70 years (73%), with only 7% younger than that, and 20% older than 70 years. At MPN, where only 10 responded, half (50%) were aged 50-70 years, with the next largest group (30%) aged 40-50 years. One was under 40 years (10%) and one was over 70 years (10%).

No significant differences were found between the family members associated with the two centres with regard to the following variables:

- Whether glasses were needed to read (MPN 70%, MPW 63.2%, all provided answers)
- Whether glasses were needed to drive (MPN 66.7%, MPW 61.5%; 9 responded at MPN, 13 at MPW)
- Limited night vision (MPN was 0%, MPW 37.5%; 2 responded at MPN and 8 at MPW)
- Glaucoma (0% said yes at both MPN and MPW; 2 responding at MPN and 6 at MPW)
- Cataracts (0% said yes at MPN and 14.3% at MPW; 2 responding at MPN and 7 at MPW)
- Legally blind (0% said yes at both MPN and MPW; 2 responding at MPN and 6 at MPW)
- Other vision problems listed at MPW were nearsightedness, astigmatism, macular degeneration and "reading" (four responded) and myopia at MPN (one responded).

Table 7

Differences in Family Satisfaction at McConnell Place North and McConnell Place West with Lighting for Specific Resident Activities, The Use of Rooms for Activities, and Actual Task Lighting in the Rooms*

Activity†	MPN Percent Satisfaction (No. raters)	MPW Percent Satisfaction (No. raters)	X^2 P Value (N)	MPN Rooms Used, Hours & Duration	MPN Day/Night In lux	MPW Rooms Used, Hours & Duration	MPW Day/Night (lux)
Arts & Crafts (500 lux recommended)	100 (3)	75 (4)	.350‡ (7)	Living-Dining Room (1-4 p.m., 10 min-1 hr)	D=121-207	Kitchen , Great Room (1-8 p.m., 30 min-1 hr)	K=343-1460 G=204-377
Table Games (500 lux recommended)	66.7 (3)	100 (1)	.505‡ (4)	Living-Dining Room, Horticulture Room, Great Room (1-8 p.m., 20 min-2 hr)	D=50-207 H=666-743 G=56-1218	–††	–
Chores (500 lux recommended for kitchen tasks)	100 (4)	100 (4)		Living-Dining Room, Kitchen (8am-8 p.m., 10 min-1 hr)	D=50-207 K=114-37600	Living-Dining Room, Kitchen, (8am-8 p.m., 10 min-2 hr)	D=504-842 K=343-1460
Clerical Tasks – Writing (750 lux recommended for living room tasks)	–†† (0)	100 (2)		Kitchen (8 am-8 p.m., –††)	K=114-37600	Kitchen (–,†† 5 min)	K=343-1460
Cooking & Baking (500 lux recommended)	66.7 (3)	100 (6)	.134‡ (9)	Kitchen (8 am-8 p.m., 15 min-1 hr)	K=114-37600	Kitchen (4-8 p.m., 20min-1 hr)	K=343-1460
Dancing (300 lux recommended for walking)	100 (4)	100 (5)		Great Room (1-8 p.m., 1-2 hr)	G=56-1218	Great Room (4-8 p.m., 30 min-1 3/4 hr)	G=204-377
Eating (500 lux recommended)	100 (6)	100 (9)		Living-Dining Room (8 am-8 p.m., 1-2 hr)	D=50-207	Living-Dining Room, Kitchen (8 am-8 p.m., 30min-1 1/2 hr)	D=504-842 K=343-1460
Exercise (300 lux recommended)	100 (5)	100 (4)		Great Room (8 am-8 p.m., 15 min-1 hr)	G=56-1218	Varies (8 am-4 p.m., 20 min – 1 1/2 hr)	–††
Group Activities (300 lux recommended)	100 (4)	100 (6)		Horticulture Room, Great Room (11 am-8 p.m., 30 min-2 hr)	H=666-743 G=56-1218	Varies, Library (11 am-8 p.m., 30 min-1 hr)	Li=421-789
Music (500 lux recommended)	100 (4)	100 (5)		Great Room (8 am-8pm, 15 min-1hr)	G=56-1218	Varies, Great Room, Library (4-8 p.m., 30 min-1 hr)	G=204-377 Li=421-789
Playing Cards (750 lux recommended for living room tasks)	100 (2)	100 (3)		Living-Dining Room (1-8 p.m., 1 hr)	D=50-207	Living-Dining Room (1-8 p.m., 30 min-1 hr)	D=504-842

Activity†	MPN Percent Satisfaction (No. raters)	MPW Percent Satisfaction (No. raters)	X^2 P Value (N)	MPN Rooms Used, Hours & Duration	MPN Day/Night In lux	MPW Rooms Used, Hours & Duration	MPW Day/Night (lux)
Reading (750 lux recommended for living room tasks)	66.7 (3)	50.0 (10)	.612‡ (13)	Bedroom, Library (1-8 p.m., 1 hr)	B=40-1360 Li=68-784	Bedroom, Entertainment Room (8 am-8 p.m., 30 min-1 1/2 hr)	B=35-631 E=614-662
Walks (300 lux recommended)	100 (6)	100 (10)		Halls, Outside (8am-8pm, 15-20 min)	Ha=64-31620	Halls, Outside (11am-8pm, 15 min-1 hr)	H=200-726 Ha=64-31620
Woodworking (500 lux recommended)	–†† (0)	100 (1)		–††	–	–††	–
Grooming (600 lux recommended)	100 (7)	66.7 (6)	.090‡ (13)	Ensuite bathroom (8am-8pm, 10-30 min)	Ba=730-919	Bedroom, Ensuite bathroom (8-11am, 1-8pm, 15min-1hr)	B=35-631 Ba=994-1214
Medical Treatments (1000 lux recommended)	100 (1)	50 (4)	.361‡ (5)	Bedroom (1-4 p.m., 5 min)	B=107-1360	Bedroom (4-8 p.m., 30 min-1 hr)	B=35-631

* Daytime to nighttime ranges of lighting were compiled as they were for Table 6. However, MPN family members believed that arts and crafts and medical treatments only occurred in the afternoon, therefore the range is for daytime only

† IESNA recommendations are for minimum task lighting.

‡ SPSS reported cells with an expected count less than 5, Chi-square statistic (X^2).

†† Respondent omitted this information.

The majority did not know either their uncorrected or corrected vision rating. Three reported 20/20, one 3.5/3.0, one "7" and one "8," with 8 family members responding to this item from each centre. The single figures reported may be a diopter for one eye, but are meaningless without more information.

4.2.4 Family Ratings of the Lighting

Overall, the data indicates only that family members found lighting adequate. For eight of the 16 activities included in the survey, family members' ratings were identical, and all respondents said lighting was adequate for those activities. Light for reading was considered inadequate by one-third of respondents at MPN and one-half at MPW. The locations they suggested the residents would select for reading were their bedrooms, and either the library seating area of MPN, or the entertainment room of MPW. Only one comparison is worth noting between the two centres. Rating for grooming was significantly different at the $p < .10$ level (χ^2 (1, $N = 16$) = 2.87, $p < .090$), with 100% of MPN family members rating lighting as adequate in contrast to only 67% of MPW respondents.

By targeting family members who had some legal responsibility for the resident, it was hoped to survey family members who would be most familiar with the centre. Several of these people, however, indicated on their returned forms that they did not visit the centre often enough to rate lighting levels. Family members associated with MPN provided the following written comments on the survey (using direct quotations):

- I have not participated in any of the above activities. My time spent at MPN is always during the daylight hours when the windows and open area design makes it quite well lit in the building.

- I feel that the overhead light in each resident's room is not bright enough and certainly does not give adequate lighting for reading text unless the resident has brought their (sic) own bedside lamp.

- I do not spend enough time at MPN to answer this survey accurately.

- This letter was misplaced and I just received it this week. I visit M. every two weeks. She is always so pleased when I come. We have a good visit and have coffee. I think she is quite happy there – it is such a nice place. I don't take part in any of the activities – she is just happy to visit. The staff are very friendly – I feel quite at home!

Family members associated with MPW provided the following written comments on the survey ("rooms" in the second comment likely referred to bedrooms, although the location is more uncertain in the final comment):

- As I am in a seniors' home myself, I do not participate in any of the centre's activities.

- Rooms could have more light. Lamps required for reading now. Lighting in other areas is great.

- Poor bedroom lighting,

- Better room lighting – less shadows would be an improvement.

In conclusion, family members associated with MPN and MPW rated the adequacy of lighting at the two centres very similarly, unlike staff members, and they considered lighting adequate at both centres for most activities, which did not agree with staff assessments, nor with the results from the objective measurements of lighting levels.

Lighting levels in residents' bedrooms caused family members some concern; a concern shared by staff members. Family members represented a very different age group than staff members. With family members' predominant age range being 50-70 years, they were expected to be more sensitive to lighting requirements of residents whose average age was 81; however, this did not appear to be so.

4.3 Observation of Residents, Staff, and Visitors

4.3.1 The Residents

All 72 residents were mobile and engaged in centre activities. A no-restraint policy ensured that they were free to walk where they chose in the common areas and houses 24 hours a day. In addition, they had free access to the secure outdoor courtyards in clement weather throughout the day and early evening. The 12 residents in each house were encouraged, however, to treat the house where they resided as their home, eating all regular meals in its living-dining room, using items from its kitchen cupboards and refrigerator, and doing laundry in its laundry room. Morning exercise activities and afternoon social events, such as teas and dances, were held in the common areas of both centres daily. In addition, church services were held regularly several times a week, and a beautician was present one day a week in each centre (Milke, Beck and Ledewitz 1999). Trips outside to community events were arranged periodically. Family members occasionally took residents out of the centres for various events and arranged for family events in the centres.

The average age of residents at MPN at the time of the study was 81, ranging from 68 to 96 years, and at MPW the average was 83, ranging from 59 to 93 years. As reported in the introduction, 89% of the residents were women at MPN. At MPW, 72% of residents were women. Although there were significantly more men at MPW, this was not expected to make a difference in where residents were seen. Preliminary observations suggested the availability of a phone, coffee and snacks in the open plan kitchen meant that men were frequently observed there. Some men helped with chores around the houses. Because no gender differences in activity were anticipated, the gender of residents was not recorded on behavioural maps.

4.3.2 Numbers of Staff and Visitors in the Centres

Staff numbers and functions were similar at both centres. Each had a centre manager, a clerk-receptionist, and a program coordinator who organized recreation and activities. An outreach coordinator split her time between the two centres, primarily working with family members. The program coordinators were frequently involved in residents' activities. Although the managers at each centre were registered nurses, they did not provide direct care to residents. However, they were commonly seen among residents throughout their working day. The clerk-receptionists and the outreach coordinator were not typically seen among residents.

The numbers of resident companions, that is those who gave personal care, and licensed practical nurses (LPNs) at the two centres were identical on each full- and part-time shift throughout the day. Thus, the numbers of care staff who might be seen in each centre were identical. Between 8:00 a.m. and 3:30 p.m. two housekeeping staff worked in the centre. Support staff also included maintenance workers, but not cooks. Meals at both MPN and MPW were cooked in nearby long term care facilities, with the exception of all breakfasts and three lunches weekly, which were prepared in the house kitchens by the residents and resident companions, working together.

4.3.3 Results of Observations

Observations of staff, visitors, and residents as they engaged in the informal and organized social life in the two centres were done in the first two weeks of October 1998. Hourly scans were done from 8:00 a.m. to 9:00 p.m. on two weekdays at each centre, for a total of 28 scans at each centre. At six different hours over the two days (21.4% of all scans), two observers completed the scans together to determine inter-rater reliability. Inter-rater agreement was .856 for MPN and .860 for MPW (Cohen's *kappa*, Cohen 1960), which is rated as "excellent" by Fleiss (1981). The unit of analysis was the behavioural event.

At MPN, residents were seen in 21 of the 25 locations scanned; that is, 84.0% of locations were used over the two days. No residents were seen in the laundries in Green, Blue, and Rose houses, or in the craft room. At MPW, residents were seen in 20 of the 24 locations scanned, indicating 83.3% of locations were used. No residents were seen in the laundries in the Green and Blue houses, in the craft room, or in the family dining room.

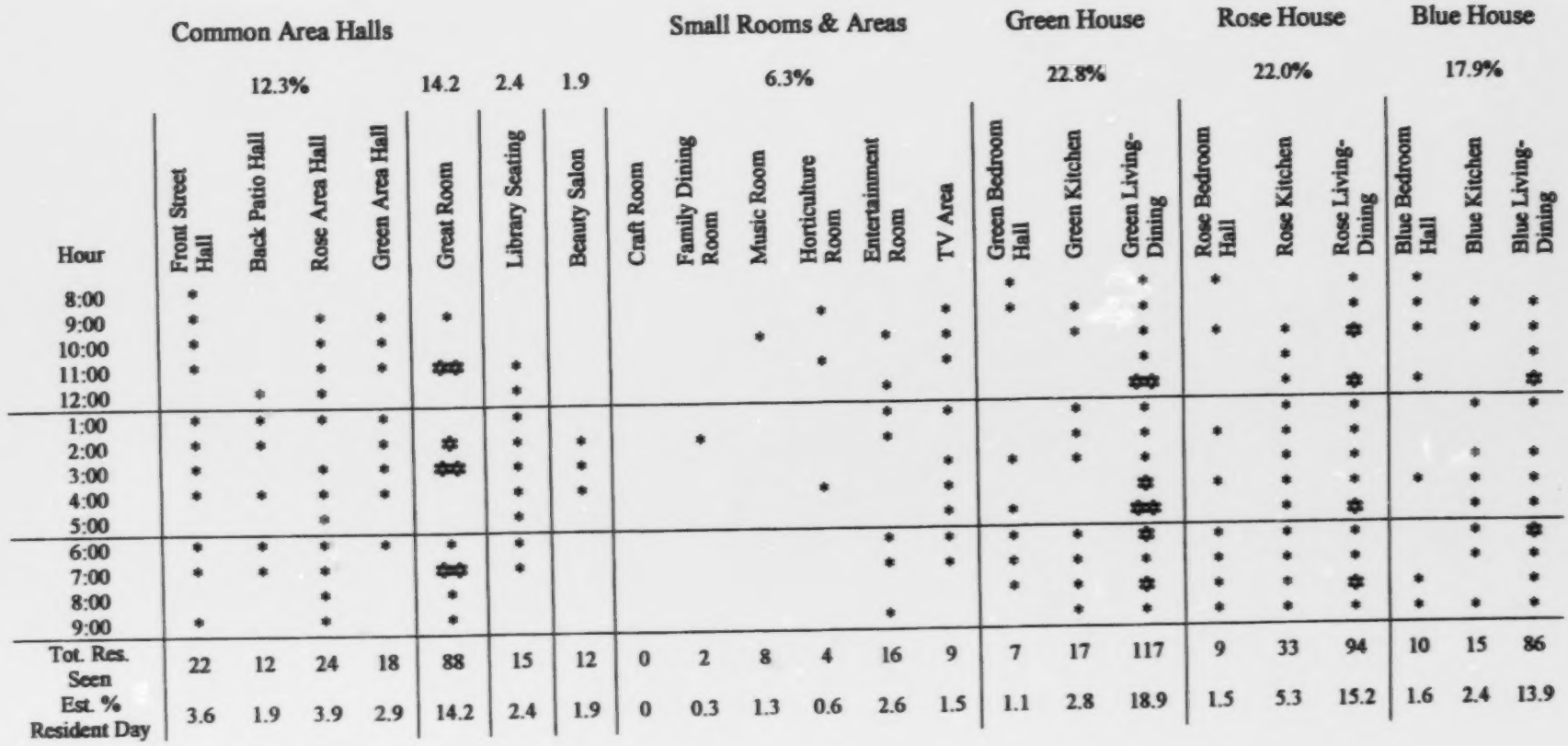
Comparisons between Day 1 and Day 2 observations determined there were no significant differences in the number of persons seen, or number of locations used, at either MPN or MPW. The beauty salon, however, was used more on one day than the other at each centre because the beautician only worked one day at each centre. With respect to activities at the two centres, "sitting" was seen significantly more on one day than the other at MPW (χ^2 (1, $\underline{N}$ = 644) = 4.03, p<.045), but no other activity varied to this extent between Day 1 and Day 2, suggesting no single activity decreased on the day that sitting increased, therefore the difference was considered unimportant. Thus, the two days of data for each centre were judged to be representative and were averaged for each centre. These preliminary significance tests were analogous to testing the reliability of a scale with the Split-Halves Method (Carmines and Zeller 1979). In this case the reliability of the observations was being evaluated.

4.3.3.1 Residents' Dispersal Patterns in the Centres

The dispersal of residents throughout the public areas during the day and evening is presented in Figure 3 and Figure 4. The residents spent the majority of their day in the three houses at both centres (62.7% at MPN and 70.2% at MPW). Most of the time in the houses was spent in the living-dining rooms, rather than in the kitchens, laundries, and bedroom halls, the other shared spaces. The Rose living-dining room at MPW had a higher occupancy rate (24.1%) than any other living-dining room at either centre.[12] Interestingly, the popular Rose living-dining room was the best lit (minimum 642 lux) of any of those particular rooms (Table 3). The MPW Blue kitchen had higher lighting (minimum 814 lux), but did not appear to attract residents; nor did the MPN Blue kitchen, which had higher lighting than other MPN kitchens and living-dining rooms.

[12] Percentages in figures and tables presenting observational data are calculated only for residents seen during observational scans. Residents who were in private spaces, such as bedrooms and bathrooms, would have been omitted because no observations were done in private spaces. Although it is likely that residents were in their bedrooms during the first and last scans of the day, one cannot assume the same is true for every scan. When some of the 36 residents were not seen they may have been in public areas, outdoors for instance, and briefly out of sight during the scan. In both centres 618 residents were seen of a possible 1008 during the 28 scans over 2 days (61.3%).

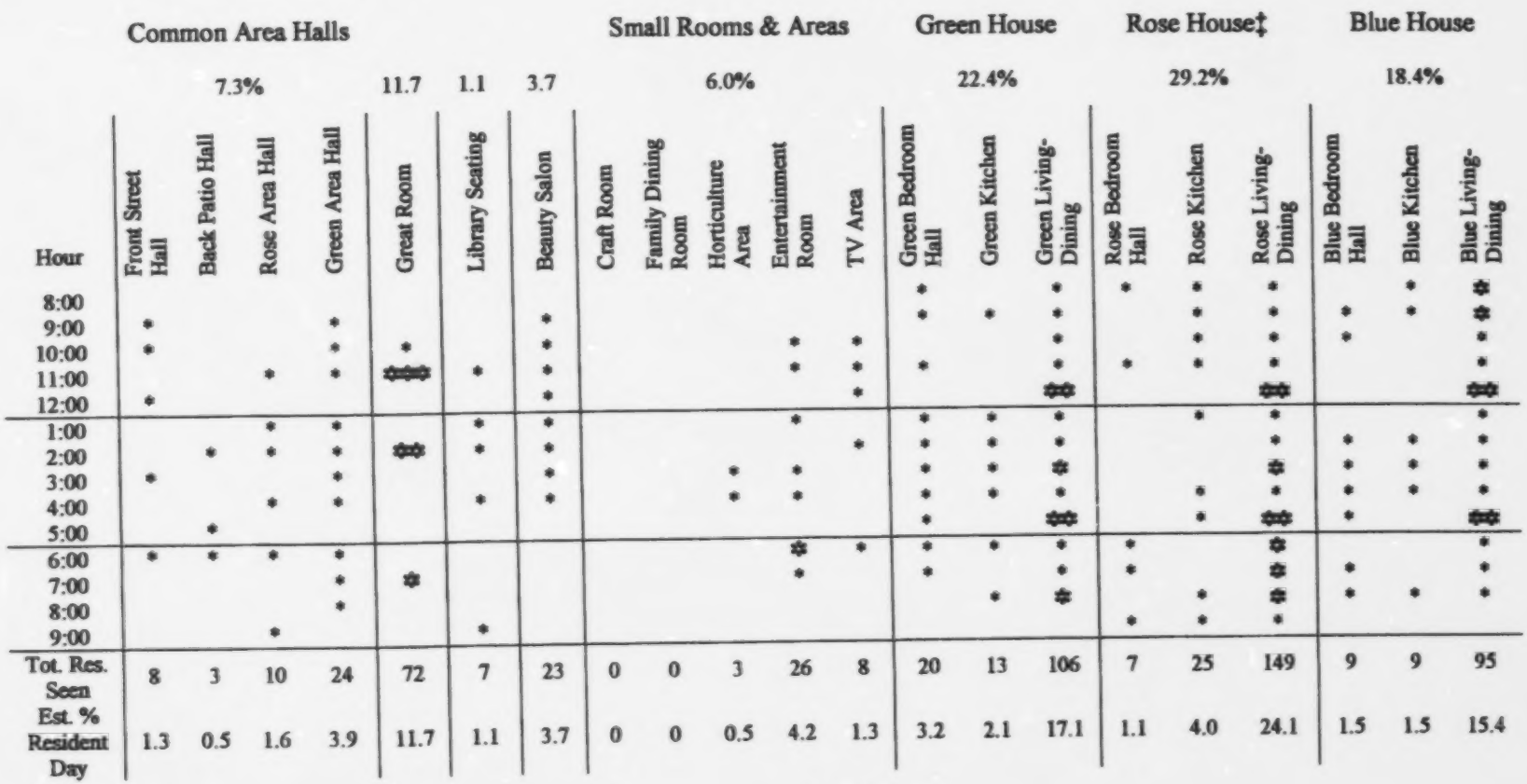
Figure 3
Location by Hour of the Day for McConnell Place North Residents over Two Days



* Less than 10 residents were in the location at this hour over two days observation.

✲ At least 10 residents were in the location at this hour over two days observation (with each additional symbol representing at least 10 more seen.)

Figure 4
Location by Hour of the Day for McConnell Place West Residents over Two Days



* Less than 10 residents were engaged in the activity at this hour over two days observation.
* At least 10 residents were engaged in the activity at this hour over two days observation (with each additional symbol representing at least 10 more seen.)
‡ In addition 1 resident was seen in Rose house laundry, accounting for an estimated 0.2% of residents' time.

Residents were seen in some locations during nearly every scan during the day. At MPN, the most continuously occupied rooms were the three houses' living-dining rooms and kitchens, the Rose area hall and the front street hall, which is consistent with information from the staff survey (Table 6). Residents were rarely seen in the family dining room, music room, horticulture room and craft room. The areas where televisions were found, the entertainment room and television area, were popular. The back patio hall, where 12 residents were seen, primarily on the day the beautician was working in the beauty salon, appeared to be used primarily as a passageway to that room, and occasionally to the great room or to doors going outside. No resident was seen sitting in the area.

Residents at MPN spent more time in the common areas (37.1%) than residents at MPW (29.8%), although the difference was not significant (χ^2 (16, $\underline{N}$ = 672) = 20.28, $\underline{p}$ <.208). Most of the time in the common areas at both centres was spent in the great room (14.2% and MPN, 11.7% at MPW) because of the planned activities held there. Residents may have been encouraged to go to the great room for these activities, but there were no planned activities in other common areas where MPN residents spent almost as much time (10.4%), such as the front street hall (3.6%), Green area hall (2.9%), and Rose area hall (3.9%). Nor were there planned activities in MPW areas such as the entertainment room (4.2%) or Green area hall (3.9%), where those residents spent substantial time (8.1%).

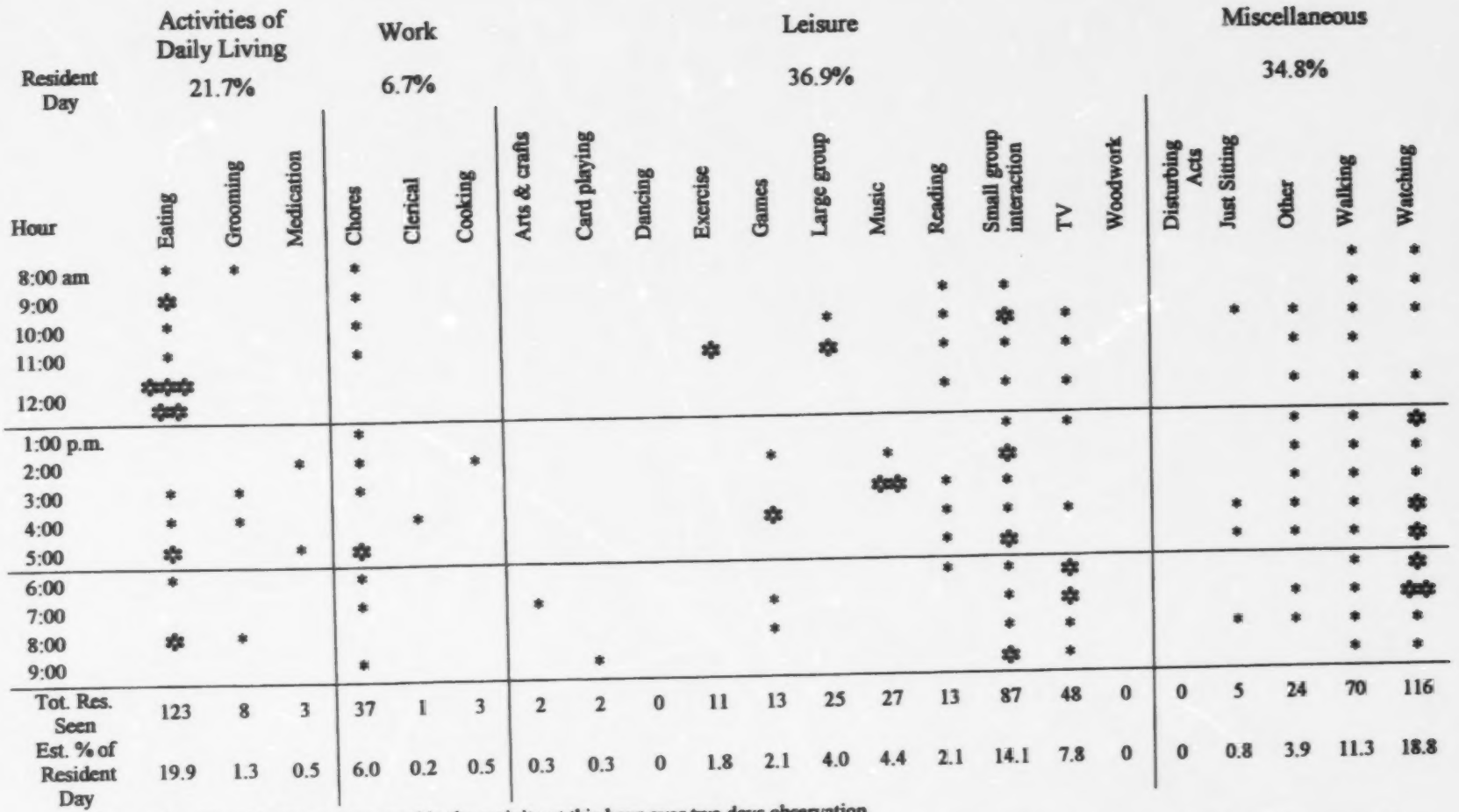
MPW residents spent more time than MPN residents in the entertainment room, the beauty salon and the Green area hall. MPN residents spent more than twice as much time as MPW residents in the library seating area, the front street hall, Rose area hall, and the back patio hall, albeit the largest percentage of time in any of these locations was only 3.6%. The horticulture room and craft room, two of the best lit areas at MPN, day or night (Table 2), were where the fewest residents were seen in that centre. Overall, the correspondence was poor between areas where lighting met IESNA minimum recommendations and areas where residents spent their time. As mentioned above in the discussion of the survey results, the house living-dining rooms at both MPN and MPW were multi-purpose rooms, used for 63% of activities (10 of 16). It was suggested that this was likely prompted by staff members' need to both oversee residents found in the living-dining rooms and to simultaneously do care tasks.

4.3.3.2 Residents' Daily Activities

The activities, 22 in all, in the observational coding scheme corresponded to the activities listed in the questionnaire sent to staff and family members, to facilitate comparisons between the two types of data. Preliminary investigation determined that all activities in the scheme were known to occur in at least one of the centres and that all activities apt to occur could be recorded using the scheme. Figure 5 and Figure 6 indicate that not all of the activities were seen during the two days of observation in each centre. No dances were held in the great room and no woodworking was seen in either centre. There were no scheduled evening events, however, on observation days. MPN had a well-attended musical event on Day 1. Only MPN residents were seen engaged in medications and treatments, clerical tasks, arts and crafts, large group activities, and cards. Surprisingly, MPW residents spent nearly 30% of their time at their meals, in contrast to MPN residents who spent 20% of their time at meals. Figure 4 indicates that residents of the MPW Rose house used their living-dining room more than residents of other houses. At MPN, the

major difference was in the evening meal when few were seen eating at the dining tables, although a number were engaged in chores moving between the tables and the kitchen as they cleared tables (Figure 5).

Figure 5
Activities by Hour of the Day for McConnell Place North Residents over Two Days

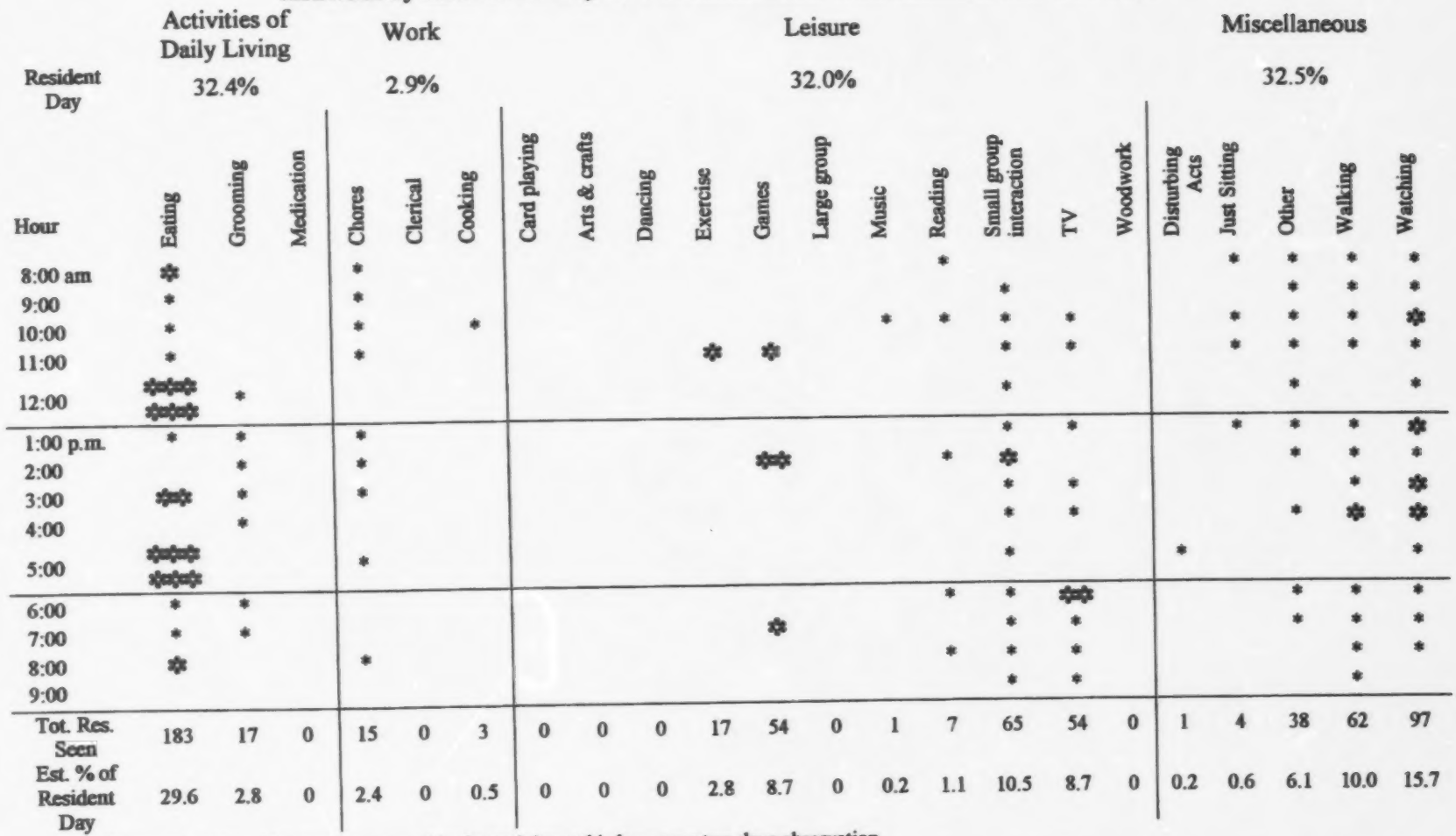


* Less than 10 residents were engaged in the activity at this hour over two days observation.

✲ At least 10 residents were engaged in the activity at this hour over two days observation (with each additional symbol representing at least 10 more seen.)

Figure 6

Activities by Hour of the Day for McConnell Place West Residents over Two Days



Resident Day	Activities of Daily Living 32.4%			Work 2.9%			Leisure 32.0%											Miscellaneous 32.5%				
Hour	Eating	Grooming	Medication	Chores	Clerical	Cooking	Card playing	Arts & crafts	Dancing	Exercise	Games	Large group	Music	Reading	Small group interaction	TV	Woodwork	Disturbing Acts	Just Sitting	Other	Walking	Watching
8:00 am	✲			*										*	*				*	*	*	*
9:00	*			*											*					*	*	*
10:00	*			*		*							*	*	*	*			*	*	*	✲
11:00	*			*						✲	✲				*	*			*	*	*	*
12:00	✲✲✲ ✲✲✲	*													*					*		*
1:00 p.m.	*	*		*											*	*			*	*	*	✲
2:00		*		*							✲✲			*	✲					*	*	*
3:00	✲✲	*		*											*	*					*	✲
4:00		*													*	*				*	✲	✲
5:00	✲✲✲ ✲✲✲			*											*			*				*
6:00	*	*												*	*	✲✲				*	*	*
7:00	*	*									✲				*	*				*	*	*
8:00	✲			*										*	*	*					*	*
9:00															*	*					*	
Tot. Res. Seen	183	17	0	15	0	3	0	0	0	17	54	0	1	7	65	54	0	1	4	38	62	97
Est. % of Resident Day	29.6	2.8	0	2.4	0	0.5	0	0	0	2.8	8.7	0	0.2	1.1	10.5	8.7	0	0.2	0.6	6.1	10.0	15.7

* Less than 10 residents were engaged in the activity at this hour over two days observation.

✲ At least 10 residents were engaged in the activity at this hour over two days observation (with each additional symbol representing at least 10 more seen.)

Residents at MPN spent about twice the time doing household chores (easy housekeeping tasks) (6.0%) and reading (2.1%), compared to residents at MPW (2.4% and 1.1%, respectively). MPW residents spent twice as much time in grooming activities. Figure 3 and Figure 4 indicated that twice as many were seen in the beauty salon at MPW, which may have occurred because of the duration necessary for some hair processes, individual preferences, or weekly variations in hairdressing schedules.

The amount of time spent in games at MPW (8.7%) was approximately four times the amount spent at MPN (2.1%). However, MPW was apt to have games that required exercise rather than traditional stretching exercises. The former would have been recorded as games, the latter as exercise, which may account for this difference between the centres (Appendix J has definitions for all activities). A substantial amount of residents' time in both centres was spent in relatively sedentary activities such as watching others, or street traffic, and watching television, and "just sitting," which indicated that the resident was not only sedentary but appeared to be oblivious to events around him or her.

Many of the percentages of time spent in various activities were relatively small, considering eating, small group interactions, and watching television consumed the major portion of the residents' day (Figure 5 and Figure 6). Small group interactions, as defined in the coding scheme (Appendix J), included participating in person-to-person communication through conversation, gestures or touch.

The percentages in Figure 5 and Figure 6 can be interpreted as a time budget for residents in each centre. Based on the activities that predominate, the most important areas for residents to have adequate lighting would appear to be where they eat, interact in small groups, and watch television. Such results are often found in research with residents in long term care settings (e.g., Hiatt Snyder 1973; Regnier, 1994). The range of activities should influence lighting chosen for areas. The residents obviously need appropriate lighting for chores, grooming, reading, artistic endeavours, games of various sorts, cards, cooking, and clerical tasks. A number of these require a minimum of 750 lux according to the new IESNA age-adjusted lighting recommendations.

Patterns of activity are evident in Figure 5 and Figure 6. All residents joined in meals, and most had snacks (eating in the figures), so the most concordance in behaviour occurred at that time. Residents participated in no other activity to the same extent, although watching at MPN and games at MPW attracted large numbers of residents. Examining the times of the two major meals, lunch at noon and dinner at 5 p.m., it is evident that residents were involved in other activities, even at those times. Some activities like small group interactions, walking, and chores occur through the day. This suggests that residents require appropriate lighting for such activities throughout the day and evening.

Figure 7

Resident Activity by Location in McConnell Place North and McConnell Place West for Two Days*

Location	McConnell Place North (Total Residents Observed = 618)				McConnell Place West (Total Residents Observed = 618)			
	Activities of Daily Living	Work	Leisure	Miscellaneous	Activities of Daily Living	Work	Leisure	Miscellaneous
Blue House	✲✲✲✲✲	✲	✲✲	✲✲✲	✲✲✲✲✲✲	*	✲	✲✲✲
Rose House	✲✲✲	✲	✲✲✲✲	✲✲✲✲	✲✲✲✲✲✲	*	✲✲✲✲	✲✲✲✲✲✲
Green House	✲✲✲✲✲	*	✲✲✲✲✲	✲✲✲	✲✲✲✲✲✲	*	✲	✲✲✲✲✲
Small Rooms†		*	*	*				*
TV Areas‡		*	✲	*			✲✲	*
Common Halls††	*	*	✲	✲✲✲✲✲	*		✲	✲✲✲
Library		*	*	✲			*	*
Great Room			✲✲✲✲✲✲	✲✲			✲✲✲✲✲	*
Beauty Salon	*		*	*	✲		*	*
% of Resident Day	21.7%	6.7%	36.9%	34.8%	32.4%	2.9%	32.0%	32.7%

* Activities of Daily Living include: eating, grooming, and medications; Work includes: chores, clerical, and cooking; Leisure combines the same 11 activities, and the Miscellaneous category includes disturbing acts, just sitting, other, walking and watching. These are the activity categories used in Figure 5 and Figure 6

† Small rooms include craft, music, horticulture, and family dining rooms

‡ TV Areas include the entertainment room and the TV area

†† Common halls include the front street, back street, green area, and rose area halls

4.3.3.3 Residents' Activity by Location

Figure 7, like Figure 3 and Figure 4, underscores the importance of the houses to residents' activity patterns. The primary locations for all categories of activity were the houses. However, leisure activities occurred everywhere, except in the MPW small rooms. Small special purpose areas and rooms were relatively unimportant to resident activity patterns, particularly at MPW (which had one less of these, having no music room).

Residents in the two centres differed in some activity patterns. MPN residents performed chores in most areas listed in Figure 7, but MPW residents only did these tasks in their houses. MPW residents engaged in more activities of daily living and miscellaneous activities in their houses than MPN residents did in theirs. This may have resulted from residents' individual preferences or slight variations in programs. Another study done in these centres found the programs were similar (Milke, Beck and Ledewitz 1999), thus individual preferences may be a key factor. The analyses of both residents' location, and activity, by hours of the day indicate that appropriate lighting is necessary in all of the locations intended for resident use throughout their waking hours.

4.3.3.4 Staff Members

At MPN, staff members spent the majority of their time in the house kitchens. Those assigned to the Green house were there for 13.0% of their time throughout the day and evening, in Rose house 15.3%, and in Blue house 9.6%. The second most likely location that staff would be found was in the dining rooms: Green house, 5.6%, Rose house 2.8%, and Blue house 6.8%. At MPN Green and Blue houses, staff were found in the dining room at various times across the day, but more were seen around meal times. Staff members in the Rose house were consistently seen in the kitchen, and not in the Rose living-dining room. The majority of staff time outside the houses was spent in the great room (13.6%).

For MPW, the majority of time staff spent in the houses was spent in the kitchens: in Green 18.2%, Rose 12.7%, and Blue 10.3%. The second location they were most likely found was the living-dining room: in Green 5.6%, Rose 11.1%, and Blue 7.1%. The majority of staff time outside the houses was spent in the great room (13.5%).

4.3.3.5 Resident Activity Alone and in The Presence of Staff

Resident activity, when alone and when in the presence of staff, was analyzed to determine the extent of residents' engagement in activities on their own, and with leadership of staff. Figure 8 and Figure 9 show good agreement between the activities residents do when alone and when guided by staff members. However, residents at neither centre exercised, nor engaged in activities like large group activities and card playing when staff were not present.

Some differences between the centres are evident in Figure 8 and Figure 9. Residents at MPW were seen lingering at meals and snacks approximately twice as much as MPN residents. Nearly half the time there were no staff in the room with them. An analysis of activity by location and time (not illustrated), confirmed that MPW residents often gathered in their houses at the tables

in the living-dining rooms, whereas MPN residents were there primarily at meal times. This was in accord, perhaps coincidentally, with the objective measurements of ambient light levels and higher minimum daytime readings in all of the MPW living-dining rooms (512, 642, 574 lux), compared to the corresponding measures at MPN (121, 132,162 lux; Table 3). However, the patterns of adequate and inadequate lighting did not match resident chores. Although chores accounted for a small percentage (6%) of MPN residents' time, twice as many MPN residents were seen doing easy household chores as MPW residents, and at MPN the same number of residents did chores on their own as when with staff, suggesting they did things like clearing dirty dishes automatically, or they could continue on their own once staff had prompted them. At MPW, residents did more chores with staff present, suggesting they needed guidance. The adequate lighting patterns were inversely related to chore activity. None of the living-dining rooms at MPN had adequate task lighting, whereas task areas in MPW living-dining rooms were well lit (Table 4). In the other rooms where tasks were done, kitchens and laundries, lighting was roughly equivalent at the two centres.

Game playing was much higher at MPW (estimated at 9% of residents' time) than at MPN (2%), and it was considerably higher at MPW when staff were present than when residents were on their own. Staff likely initiated most games. The survey questionnaire indicated MPW staff were all satisfied with lighting in the great room, kitchens and living-dining rooms for table games, and with the kitchens and living-dining rooms for playing cards. In addition, they were all satisfied with lighting in the great room for exercise, which often was a game like bowling. Activity by time by location analyses (not illustrated) revealed the observers saw a large number of MPW residents (12, 14 and 22) engaged in games in the great room on several occasions. The measurements for the MPW dining tables, another location for cards and table games, are provided in Table 4. They ranged from 574 – 842 in daytime, and from 504 – 686 lux at nighttime (less than the 750 lux minimum recommended by IESNA).

MPW residents appeared to need staff present, whereas MPN did not, to engage in chores, games, and some other activities. However, there were a number of other activities that MPW residents did more often when they were on their own. These included small group interactions, which usually involved two or more people engaging in a discussion, walking, watching (which may have been watching others do some task or watching traffic), and miscellaneous activities. Some activities that residents did on their own seem to require further explanation, considering the residents' diagnosis of Alzheimer's disease. The MPN resident engaged in a clerical task on her own was writing in her daily journal (Figure 5). A number of residents still read, and several took notes when they used the kitchen telephone. The medical treatment done without staff participation in MPN was a resident receiving oxygen treatment several times during the day. These both occurred in the Blue living-dining room.

In conclusion, residents did not appear to prefer well-lit areas for their activity, with the possible exception of MPW residents and their apparent preference to linger in their living-dining room. Light did not appear to be a factor in the number of residents seen doing chores or playing games, or where they were involved in watching or walking. The concordance between the location of resident activity and the adequacy of lighting was not strong enough to pursue through more detailed analyses. The poor concordance was not surprising, considering both

centres held the same types of activities, and one centre had generally poor lighting, whereas the other had generally good lighting.

Figure 8
McConnell Place North Residents' Activities
When Alone and in the Presence of Staff

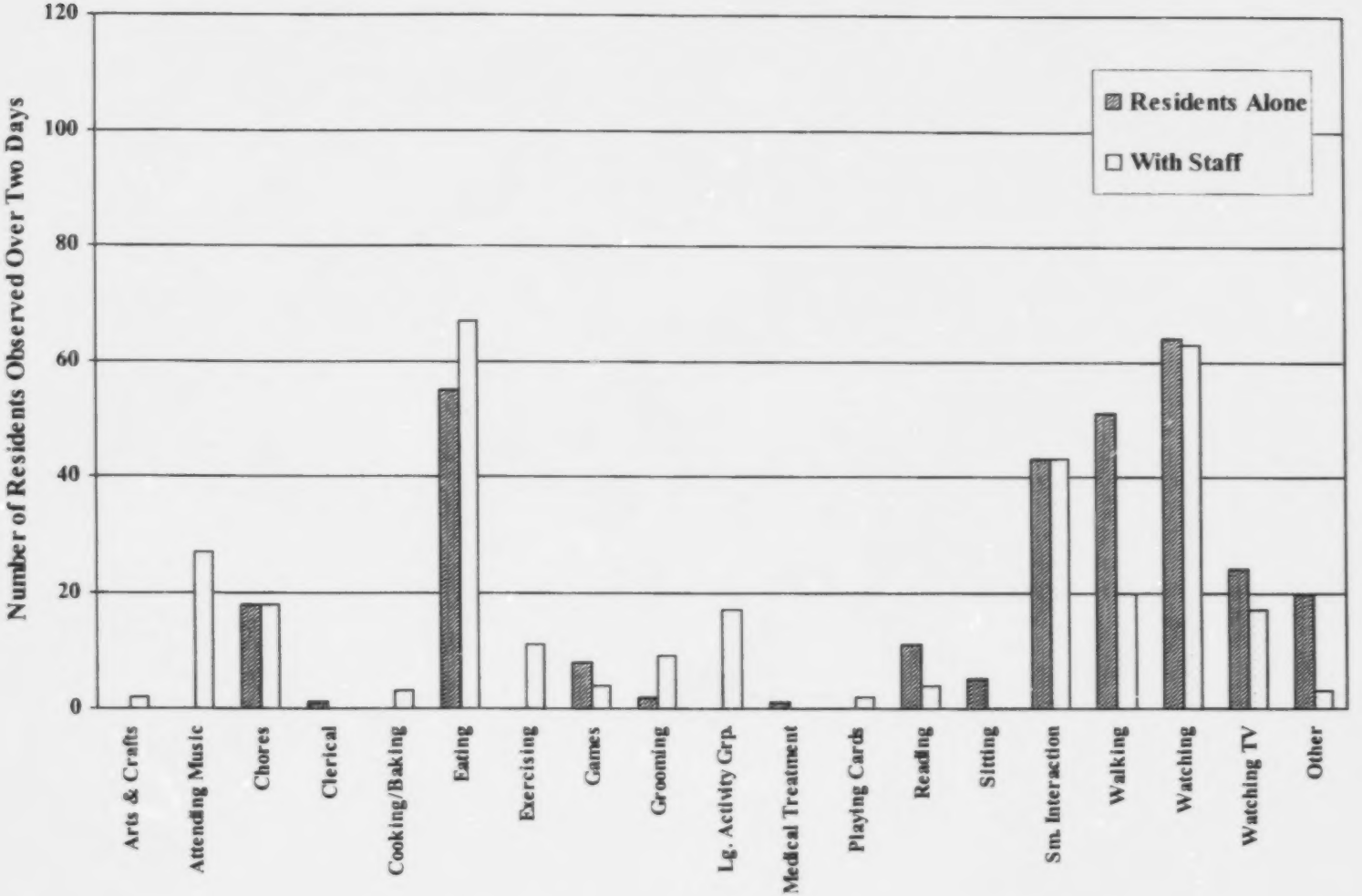
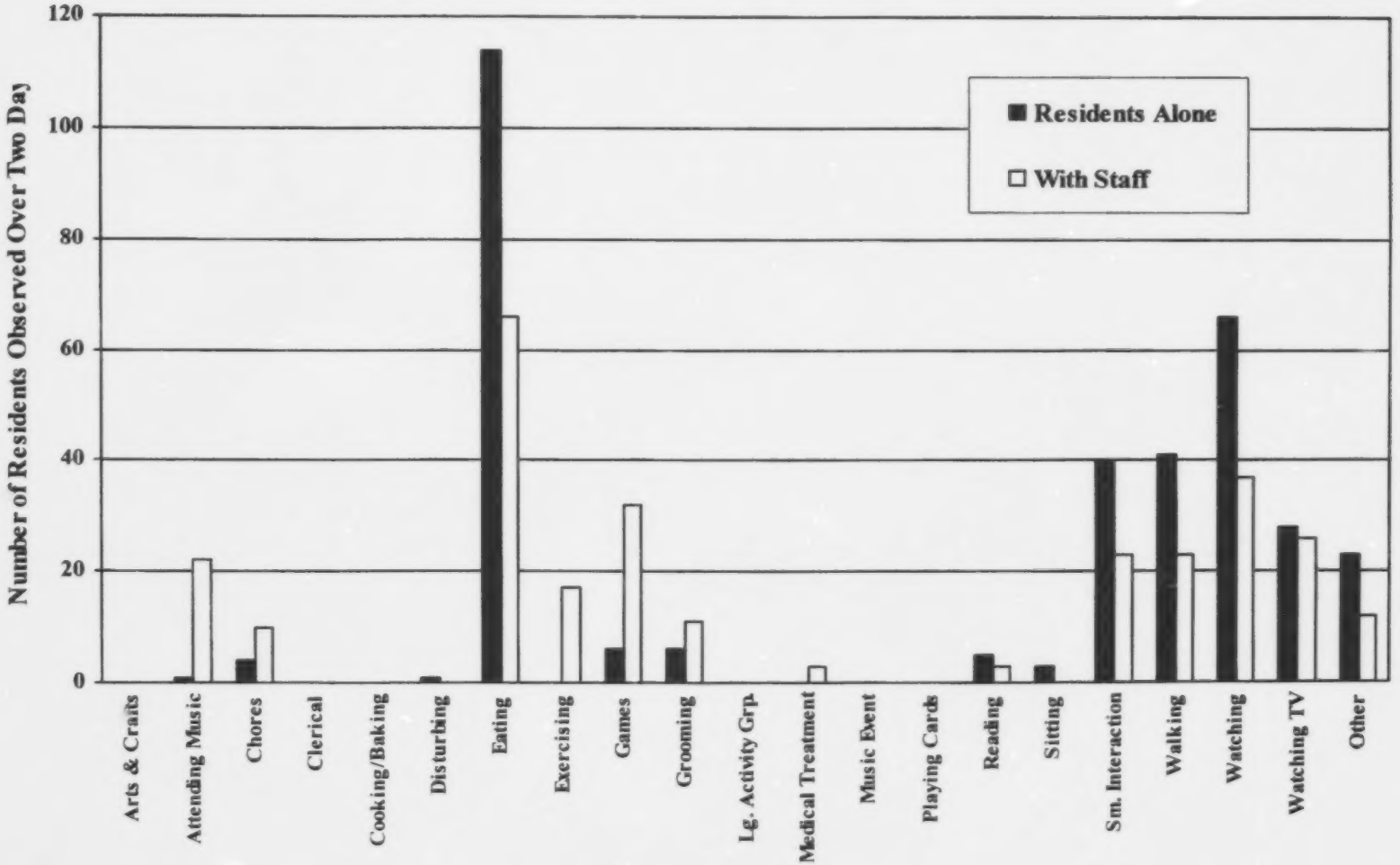


Figure 9
McConnell Place West Residents' Activities
When Alone and in the Presence of Staff



4.3.3.6 Family Member Visits to the Centres

Figure 10 and Figure 11 illustrate the location, as well as the activities in which residents participated while family members visited in public areas or shared rooms. Only those residents that were in the same room or area at the time a family member was seen were included. At MPN, 40 family members were seen during the two days of observation. Two observations of a Family Council Meeting in the great room (at 7 p.m. and 8 p.m.) inflated the number. At MPW, 24 family members were seen over the two days. There may have also been family members visiting in residents' bedrooms, but such visits would not be recorded because private areas were not observed. The time of day family members were seen in MPN was between 3 p.m. and 9 p.m., and in MPW between 10 a.m. and 9 p.m.

The main locations in MPN that family members were seen were the three houses' living-dining rooms, the Rose kitchen, the front street hall, and the great room. All were places residents were typically seen, although the front street hall was not as well frequented as the other rooms (see Figure 3). However, the horticulture room, which was seldom used by residents, was used for visiting, and two family members (children) were seen in the craft room without staff or residents present. The activities residents were involved in at MPN during family visits were typical for them (see Figure 5): eating, walking, watching, chores, reading, and small group interactions, which would describe the activity of visiting.

Similarly, at MPW the locations that family members were seen were the Green and Rose living-dining rooms, the Rose kitchen, and the Green area hall. In addition, family members visited in several areas that were not as regularly used by residents: the television area, front street hall, Rose area hall, Blue bedroom hall, and beauty salon (see Figure 4). The activities residents were involved in during visits were: chores, walking, eating, watching, grooming, and small group interaction (i.e., visiting). Except for the visit during grooming (the beautician was working on the resident's hair), these are activities that occurred regularly (see Figure 6).

Family members appeared to disperse throughout the centres and were present when residents were engaged in frequently seen activities like eating and walking, as well as less frequently seen activities such as chores and reading. As a result, one could expect that family members could judge the adequacy of lighting in diverse areas for a number of activities. This suggests that family members' answers to the survey, which investigated lighting adequacy for various resident activities, came from first-hand experience, if the survey was completed by those family members who visited.

Figure 10
All Family Members and Family Resident Groups Seen Over Two Days at McConnell Place North
(F=Family Member, R=Resident;
Day 1 in Grey, Day 2 in Black)

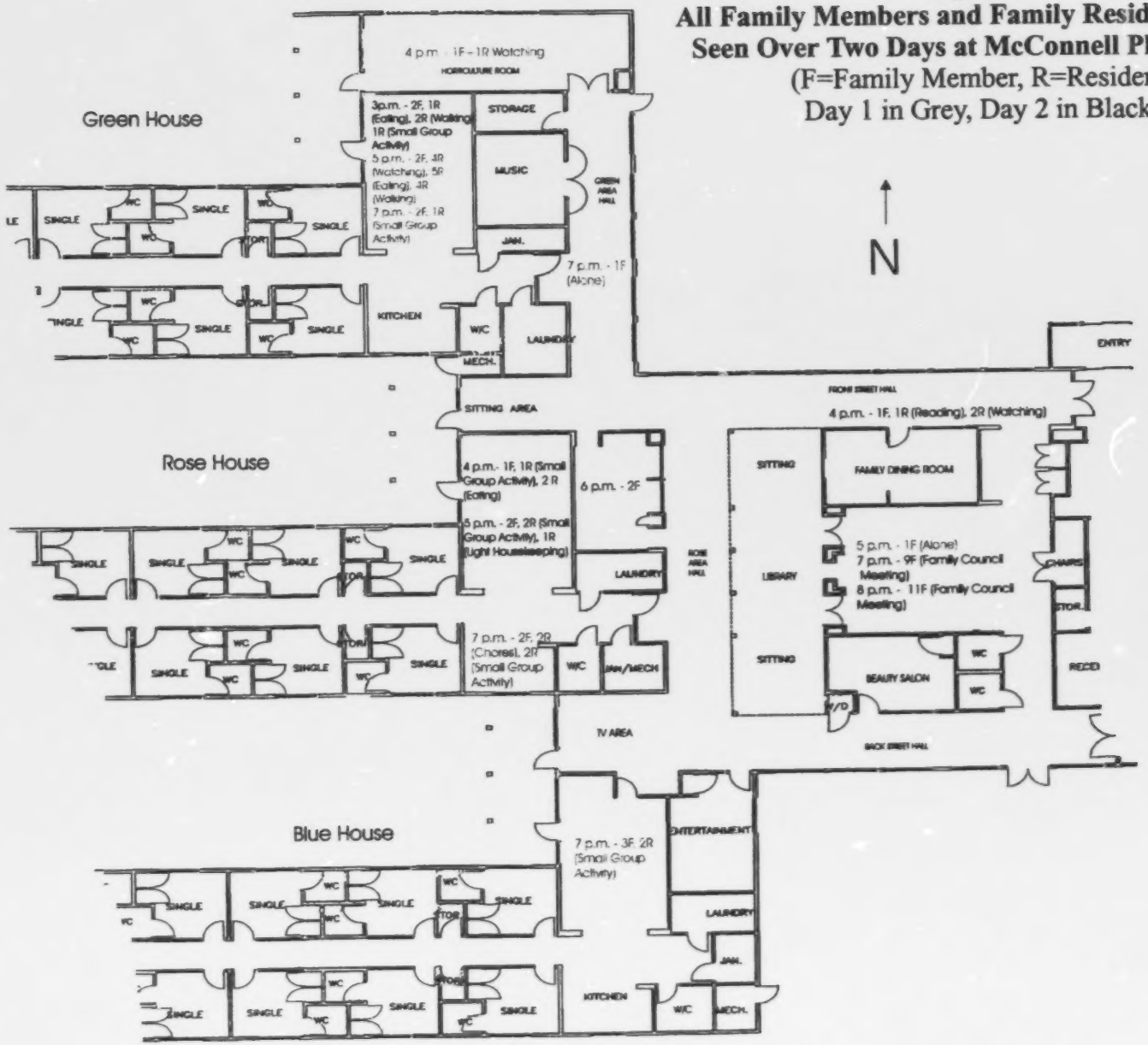
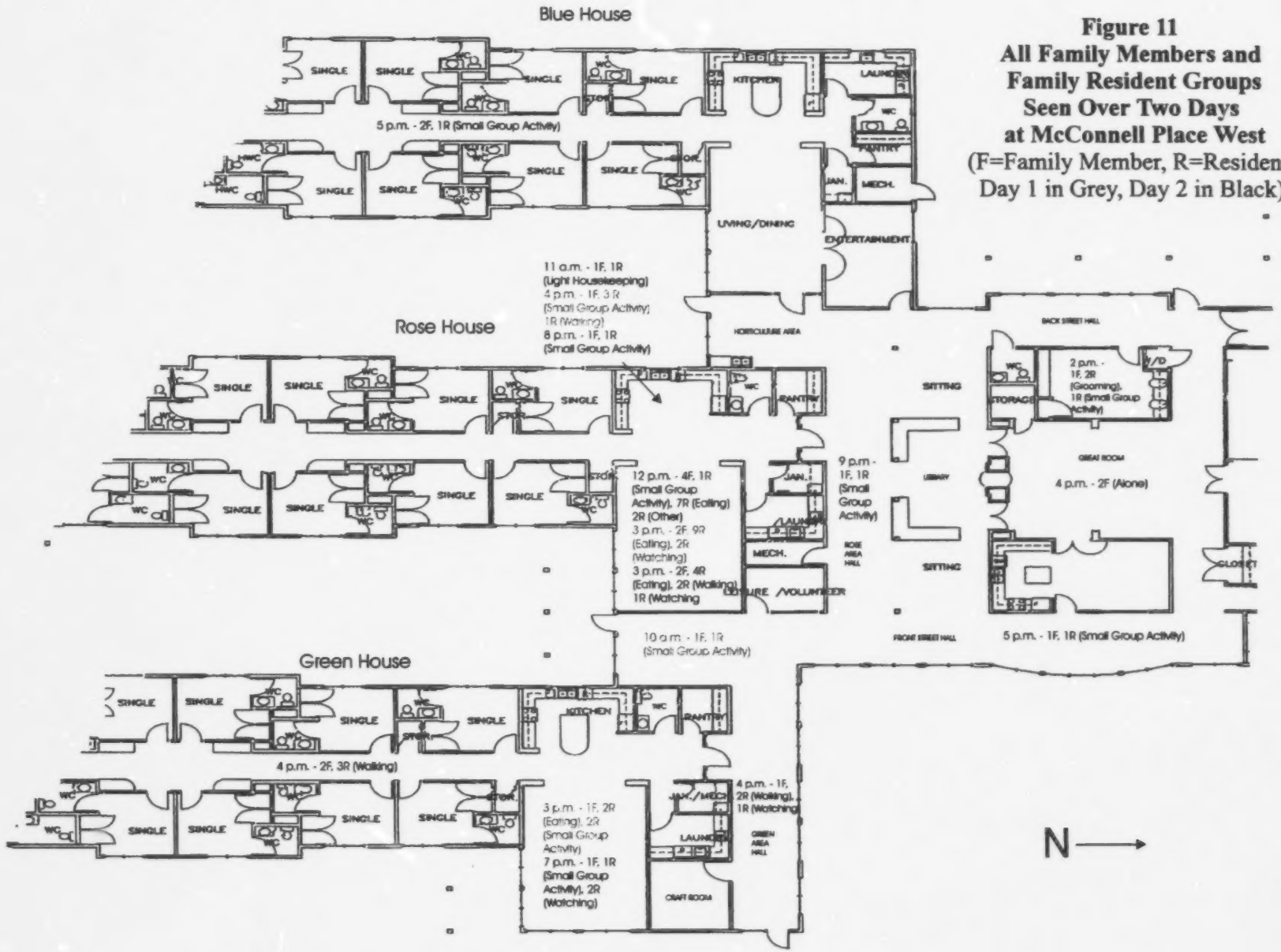


Figure 11
All Family Members and Family Resident Groups Seen Over Two Days at McConnell Place West
(F=Family Member, R=Resident; Day 1 in Grey, Day 2 in Black)


Blue House
5 p.m. - 2F, 1R (Small Group Activity)
11 a.m. - 1F, 1R (Light Housekeeping)
4 p.m. - 1F, 3 R (Small Group Activity; 1R Walking)
8 p.m. - 1F, 1R (Small Group Activity)
Rose House
12 p.m. - 4F, 1R (Small Group Activity), 7R (Eating) 2R (Other)
3 p.m. - 2F, 9R (Eating), 2R (Watching)
3 p.m. - 2F, 4R (Eating), 2R (Walking) 1R (Watching)
9 p.m. - 1F, 1R (Small Group Activity)
10 a.m. - 1F, 1R (Small Group Activity)
2 p.m. - 1F, 2R (Grooming), 1R (Small Group Activity)
4 p.m. - 2F (Alone)
5 p.m. - 1F, 1R (Small Group Activity)
Green House
4 p.m. - 2F, 3R (Walking)
3 p.m. - 1F, 2R (Eating), 2R (Small Group Activity)
7 p.m. - 1F, 1R (Small Group Activity), 2R (Watching)
4 p.m. - 1F, 2R (Walking), 1R (Watching)
SINGLE
KITCHEN
LAUNDRY
PANTRY
LIVING/DINING
ENTERTAINMENT
HORTICULTURE AREA
SITTING
LIBRARY
GREAT ROOM
STORAGE
CLOSET
CRAFT ROOM
N

CHAPTER 5 – SUMMARY

Both Alzheimer centres, which were built before IESNA published its age-adjusted lighting recommendations in 1998, did not meet the age-adjusted recommendations for lighting levels in many areas of the buildings. However, MPW, the centre with enhanced lighting, fared far better than MPN. Both centres appeared to make good use of daylighting, that is the gathering of direct and reflected natural light deep into the building, because areas that met the IESNA minimum recommendations during the day were deficient at night when artificial light was the only lighting source.

Task lighting, face level lighting, and transition areas were the main lighting issues that arose through objective measurement of lighting levels in resident areas of the two centres. The diverse activities in which residents engaged suggest they needed appropriate task lighting throughout the day and evening. At 9 p.m. in each centre some residents were observed to be still involved in activities in various locations. Good task lighting was often difficult to locate. In particular, it was difficult to find an easy chair with good reading light, day or night. Staff members at MPN appeared well aware of areas with poor task lighting, based on their responses to the survey. MPW staff members were unhappy only with lighting for medications and treatments, which they usually provided in the residents' bedrooms. Family members associated with both centres were generally happy with the lighting, except in the residents' bedrooms. Face level lighting was an issue in halls because ambient light was so low that facial recognition was a potential concern, considering the average age of residents was over 80. Another issue in halls arose from transition areas where residents could step from the relative gloom of a hall into bright outdoor daylight. The lighting systems appeared not to have been designed with transition areas at these locations; however, IESNA recommended relatively bright light in daytime, and relatively low light at nighttime, to allow aged eyes to accommodate to the change in lighting levels and decrease the possibility of falls.

5.1 Light Meter Measurements and Correspondence to Other Measures

All daytime minimum measurements for ambient light in the common areas at MPW and MPN, with the exception of three areas in MPN and one area in MPW, were higher than the new age-adjusted minimums recommended by IESNA (1998). The library seating area, Rose area hall, and music room at MPN, and the back patio hall at MPW were the deficient areas. At nighttime, however, most common areas in MPN did not meet minimum recommended light levels. Only two rooms, the craft and horticulture rooms, met and exceeded the recommended levels. At MPW, the nighttime minimum measures met the new age-adjusted IESNA minimums in seven areas, but three areas were below the minimums recommended. The great room, Rose area hall and front street hall were the deficient areas.

Very likely measured differences between similar rooms in the two settings are attributable to both natural daylighting and higher light intensity from fixtures at MPW, considering that the physical attributes of the space (such as differences in colour of walls and rugs, etc.) were highly similar. Daylighting could be expected to be more effective at MPN because of an unprotected south-facing window wall that exposed the central part of the building to bright light, and MPN showed larger differences between day and night measurements than MPW. For example,

measurements in the back patio hall dropped from a maximum of 31 620 to 170 at night. The minimum during the day was 1364, whereas at night it was 138. Similarly, the MPN great room measurements all dropped from well over 1000 lux to approximately 60 lux, one-twenty-third of the daytime reading. The largest change seen at MPW between day and night was in one common area hall where the minimum changed from 726 to 320 lux. Thus, the placement of north and south main windows at MPN and the east and west main windows at MPW influenced the results. Reaction at the two centres to these results suggest that some persons in the continuing care field who are involved in planning such centres are not fully aware of the impact of building orientation. The daylight diagrams in the 1998 IESNA document, *Lighting and the Visual Environment for Senior Living,* illustrate the effectiveness of various daylighting strategies, but may not be familiar to staff who become involved in functional design issues.

Task lighting in less than half of the common areas at MPN met or exceeded IESNA minimum recommendations. Three areas had ranges where the maximum measurement recorded met the recommended level but the minimum did not, which meant that somewhere in the area the recommended light level could be found, but lighting was not consistently adequate for tasks. An extreme reading of 32 500 lux was measured at tables in the south-facing MPN back patio hall. This was more than double the exterior reading of 11 700 lux measured at the window in this hall Task lighting in only two common areas at MPW met or exceeded the minimum recommendations, six did not, and two areas had minimum readings that did not meet the IESNA minimum recommendation, although the maximum did. Results were the same at night, although generally readings were lower. IESNA recommends the same level of task lighting for daytime and nighttime. At nighttime there were no MPN areas where task lighting met IESNA minimum recommendations at every measurement spot, although four areas had maximum measurements that met the IESNA recommendations and minimums that did not.

In the three residential houses, Green, Rose, and Blue, ambient light levels were remarkably different in MPN and MPW. In daytime, MPW had from 400 to 600 more lux in the living-dining rooms than MPN, even though the measurements at MPN were taken on a day of constant sun and those at MPW were taken in intermittent sun. The same pattern of differences between MPN and MPW was seen in the kitchens and bedroom halls. At nighttime the differences between lighting in the two centres typically increased. Of these rooms, only some spots in the MPN kitchens met IESNA recommended minimums, day or night.

The bedrooms that staff selected as brightest were very different in the two centres. At MPN, the bedroom faced south and had no barriers to natural light. Measurements for ambient light were very high during the day, and fell dramatically at night. At MPW, the bedroom in the same location faced west; it too had no barriers to natural light, but the daytime measurement for the room midpoint was only 156 lux, approximately half the IESNA recommendation, and the darkest spot was 27 lux. At nighttime the midpoint fell by two-thirds and the darkest area was only 17 lux. Daytime measurements in these bedrooms found task lighting insufficient in MPW, but adequate in MPN. Light dropped dramatically after the sun went down and neither bedroom had adequate task lighting. As might be expected, the bedrooms staff considered the darkest had had insufficient ambient and task lighting at both centres, day and night.

A number of face level measurements were taken throughout the halls in the centres because ambient light was so low that it raised concerns about whether residents had sufficient light to recognize faces. Although IESNA has no recommended lighting level for facial recognition, a design professional who works with aged populations has recommended 550-650 lux to ensure facial recognition for nursing home residents (Hiatt 1991). Daytime minimum measurements at face level in the common area halls at both centres were consistently lower than measurements for ambient light. However, at MPN all except the Rose area hall were above the IESNA recommended minimum, although none of the MPW face level minimums were above the recommended level.

The bedroom halls served two purposes, and were not well lit for either. The primary function of each hall was to serve as a corridor to resident bedrooms, but a short hall at the end, like the crosspiece to a capital letter T, had an exit leading to a secure courtyard. IESNA recommends 300 lux for a corridor. However, for an interior exit it recommends 1000 lux during the day to facilitate transitions between the bright light of the outdoors and the comparatively dull light of indoors during the daytime. At nighttime the brighter light would be indoors, and therefore 100 lux is recommended, again to provide a transitional area. The lighting system in the hall did not meet any of these criteria well. Minimum measurements of ambient light were below 300 lux in all bedroom halls of both centres. Minimum face-level measurements were over 1000 lux at the doors in MPW, thus halls there met one daytime criterion. Face level measurements were well below the criterion at MPN. In addition, measurements revealed a possible lighting design flaw. At MPW, a dark spot was discovered in the short portion of the hall. A resident entering from the outdoors would encounter this dark spot a few steps into the hall. This could be hazardous, considering the literature attributes resident falls to such lighting situations.

The back patio hall at MPW, with a median reading of only 450 lux, did not appear to be a good transitional area either. However, the exterior of the window in this hall measured only 382 lux, suggesting that the roof overhang provided residents with a satisfactory transition area. A lux measurement of 1999 at an unshaded part of the exterior back wall provided evidence that the roof overhang was doing its job.

The variation in the measurements taken along the length of many halls revealed that the lighting was uneven on the horizontal plane. The variations noted between face level and floor level indicated lighting was also uneven on the vertical plane. Although such variation is considered relaxing by lighting experts who recommend non-uniform lighting, this runs against the advice other experts who recommend uniform lighting for persons with Alzheimer's disease (Brawley 1997). This preference for such lighting variations may not have been tested with the aged.

5.2 Survey of Family and Staff Members and Correspondence to Other Measures

The survey of staff members and residents' family members provided a subjective assessment of the adequacy of lighting in the two centres. Responses were expected to identify problematic lighting areas for a variety of activities known to occur in the centres.

Not surprisingly, staff members at the centre with enhanced lighting were largely satisfied with the lighting conditions, whereas those at the other centre were largely dissatisfied. MPN staff

were not 100% satisfied with lighting for any of the 16 activities on the survey, but more were unhappy with lighting for chores, reading and medical treatments than other tasks. MPW staff gave 100% endorsement to lighting for all but six activities. Of these six activities, four occurred in the resident bedrooms, suggesting lighting in bedrooms was problematic. This was supported by the one written comment from a staff member at MPW. In contrast to that single comment, MPN staff members added a number of criticisms that addressed several lighting issues. Their comments stem from a tradition of speaking frankly about issues during the four years that MPN has been open. Individual staff members have provided some very practical lighting suggestions, such as suggesting that free-standing lighting fixtures for persons with Alzheimer's disease need to be balanced so that almost all of the weight is in the base. They said fixtures should not have large shades with different diameters at the top and bottom, because the wider part of the lamp is frequently bumped and the lamp knocked off balance. They also advised against placing compact fluorescent tubes in fixtures, like table lamps, that residents turn on and off, because the residents expect instant light and are apt to turn a switch until it is broken (Milke 1996).

Overall, staff members' rating of the adequacy of lighting were remarkably different at the two centres, which is consistent with the results from the objective measurements of lighting levels. Measurements in MPW, the centre with enhanced lighting, better matched the IESNA recommendations than MPN. Based on IESNA recommendations for minimum lighting, minimum light levels in MPN were too low for most of the 16 tasks in the survey. In general, task lighting appeared to be poorer than ambient lighting in many areas.

Family members associated with MPN and MPW rated the adequacy of lighting at the two centres very similarly, unlike staff members. They considered lighting adequate at both centres for most activities, which did not agree with staff assessments, nor with the results from the objective measurements of lighting levels. They differed in just a few areas. All family members at MPN rated lighting for grooming as adequate, but at MPW only 67% considered it adequate. Light for reading was considered inadequate by one-third of respondents at MPN and one-half at MPW. Responses suggested they believed residents should have adequate light for reading in their bedrooms. Objective measures also indicated that light was too low for reading in most locations in the bedrooms.

5.3 Observations and Correspondence to Other Measures

One of the research goals was to determine whether residents used the two centres differently and whether this might be related to the lighting levels at MPN or MPW. Results indicated that residents spent the majority of their day in the three houses at both centres (62.7% at MPN and 70.2% at MPW). Ambient light in the houses at MPN was much lower than at MPW, which did not appear to drive residents away. Most of the time in the houses was spent in the living-dining rooms at both centres, with the MPW Rose living-dining room having the highest occupancy rate of any living-dining room at either centre. The MPW Rose living-dining room was also the best lit of any of those particular rooms. However, better lit areas such as MPW Blue kitchen did not appear to attract residents. The living-dining rooms, kitchens, and halls at MPW had enhanced lighting, but this evidently did not encourage residents there to spend more time there.

Residents' activity patterns centred around their houses. In fact, the primary location for all categories of activity was the houses. The house living-dining rooms at both MPN and MPW were evidently multi-purpose rooms, being used for 10 of the 16 activities. This was likely due to the nature of the care program rather than satisfaction with lighting, at least in MPN, because 50% of MPN staff said they were dissatisfied with lighting in that location for activities like playing cards and arts and crafts.

The great room was the most heavily used area in the common areas. Typically, three events or large group activities were held there every day. Residents may have been encouraged to attend those, but they voluntarily spent time in several other locations in the common area. At MPN residents frequented the front street hall, Rose area hall, and Green area hall, in total spending almost as much time there as in the great room. At MPW, the residents' favourite areas in the common area were the Green area hall and entertainment room. The favourite areas were not the best lit, and the better lit rooms in the common areas did not appear to attract residents. At MPN the two best lit rooms were rarely used.

Direct observation indicated that the same types of resident programs were conducted in both centres, therefore enhanced lighting did not dramatically affect the location where activities were held. Informal gatherings of residents were typically where they could have a view of some activity and interact with each other in small groups. They preferred watching activities in the kitchens of the houses, or street traffic passing the centres. Based on the resident activities that predominated, the most important areas for residents were where they ate, interacted in small groups, and watched television. However, residents engaged in a wide range of activities and, on the basis of observation, they need appropriate lighting for artistic endeavours, cards, chores (easy housekeeping tasks), cooking, clerical tasks, games of various sorts, grooming, and reading. A number of these require a minimum task lighting of 750 lux according to the new IESNA age-adjusted lighting recommendations. That level of task lighting was not available in many areas where residents chose to be.

5.4 Study Limitations

The study had a number of limitations. Exterior daytime conditions were not identical on the two days the centres were measured. As discussed above, it was constantly sunny for MPN measurements, and sun was intermittent for MPW measurements. The schedules of the technicians did not permit rescheduling the measurements at MPW to "the next sunny day." To better equate weather conditions, other comparative studies might arrange for two technicians to do readings simultaneously, which is likely the best strategy. Possibly measurements could be done over a series of days by one technician, with the same part of each centre being measured on the same day; however, in some geographical areas, such as Alberta, weather conditions can change rapidly, and such a strategy may be no guarantee of equating conditions. The weather, however, was less problematic than it could have been, because it worked against the underlying premise that MPW would have the better lighting of the two centres. If the natural lighting conditions had been consistently sunny for measurements at MPW and intermittent sun at MPN, then the effect would have been in the same direction expected for the artificial lighting. This would have resulted in daytime readings that were more difficult to interpret. Nighttime measurements were not confounded in the same way as those done in daytime. They indicated

there were reliable differences between similar areas in the two centres. Differences were not merely an artifact of exterior lighting conditions. The intermittent sun seen at MPW, however, meant that areas within that centre could not be compared as reliably as those at MPN.

The format of the questions on the survey form, which was based on the form used by Mital et al. (1992), did not allow discrete comparisons between the objective measures of lighting levels and staff members' satisfaction or dissatisfaction with levels. Staff typically reported that residents read, for example, in several locations, and then rated the lighting as inadequate for that activity. But in another item of the survey form, they indicated many of the same locations were used for another activity and lighting was then rated adequate. Only when activities were limited to one or very few locations was it possible to say that staff considered lighting in a particular area to be inadequate.

Another limitation was the low response rate from family members. Their comments suggested that they were not confident in their ability to rate the lighting for a number of reasons, including their unfamiliarity with the centre and their lack of participation in activities. A different type of form might have obtained a higher response rate. At minimum, the research team could have mailed the form to all of the family members for whom the centres had addresses. Although another strategy would have been to interview family members while they were in the centre, previous experience has indicated this is difficult because they come to visit their relative and begrudge the time spent with a researcher.

Post hoc, it would have been better to treat interior exits as distinctly separate areas from the halls in which they were located, in so far as possible. A portion of the back patio hall served as an interior exit, as well as a corridor, and the lighting was an issue. Considering it initially as an exit would have helped clarify where to take measurements, because the IESNA recommendation for the corridor function was quite different from the interior exit function. In addition, some rooms, like the entertainment rooms, could have had more measurements taken. Staff and family members reported that residents used the room for reading, yet the easy chairs were not assessed for that purpose. In hindsight, more bedrooms could have been included in the study, considering how poorly lighting in the bedrooms was rated by staff. Family members also evidenced concern with lighting there.

Another obvious limitation was the technician using a height of 5'8," his nose height, for face level lighting measurements. Although this provided normal facial reflectance from his face, the height proved to be inappropriately high for the population. IESNA will need to adapt instructions to technicians so they are appropriate for various age groups.

CHAPTER 6 - CONCLUSION

6.1 Lighting Recommendations and Alzheimer's Disease

The new IESNA age-adjusted recommendations were not written to cover the needs of special populations like persons with Alzheimer's disease. The disorder is a neurological condition that results in loss of executive brain function. The literature suggests diminished memory and reasoning capacity results in these persons being more intensively responsive to the immediate environment than those without cognitive impairment. Moreover, placing them in control of task lighting so that they can augment ambient light as necessary, as suggested in the IESNA document, is not practical. Persons with Alzheimer's disease are not usually able to make adjustments within their environment to augment light because they have largely lost their ability to analyze and problem-solve. Thus, the new recommendations may not provide enough information for those who design lighting systems in settings for Alzheimer care. Without more field research, the needs of such special populations will not be widely recognized.

This field study was precipitated by past observations that lighting levels at MPN appeared to be low, considering the age of residents. The literature was not helpful. Design professionals working with the aged advised levels that seemed more appropriate for hospital-like care settings. Yet lighting designers such as Benya (1994) suggested even acute care hospitals could be lit like a hotel, except in special areas like examining rooms. Benya's advice seemed more appropriate for a residential setting for the aged, and there were no IESNA age-related lighting guidelines available when MPN was built in 1995. A post-occupancy evaluation of MPN found that residents spent very little time in several areas with very low lighting levels. Although a number of factors could have been involved besides lighting, light levels seemed a possible cause. Therefore, when a second centre was built, the lighting levels were intentionally increased by more than four times in a number of areas of the building. In addition, the space from several areas where residents spent little time was incorporated into rooms where they were observed to spend substantial time. The footprints of the buildings remained the same. The similarity of the floor plans in the two buildings, similar residents, and similar décor suggested the present study to further investigate the influence lighting levels might play.

Field studies on lighting are rare for this population. Rarely is the lighting of a clinical setting subjected to such rigorous scrutiny. The results of this study suggested lighting levels were not a major factor in determining where residents spent time throughout the day. Direct observations showed the same types of resident programs were conducted in both centres, and the staff determined which locations would be used; therefore, it was not surprising that the enhanced lighting in MPW did not dramatically affect resident programs. It did, however, affect staff satisfaction. MPW staff were very happy with their lighting, although family members were happy with both centres. Observations also showed that MPN staff and residents managed to have activities in rooms with lighting conditions that large percentages of the staff rated as inappropriate. Like other studies, results showed that informal gatherings of residents occurred where comfortable locations were available that allowed them to interact in small groups and watch some type of activity. They preferred watching activities in the kitchens of the houses, or sitting in the halls of the common room watching street traffic passing the centres.

Several issues for design professionals emerge from this study. One was the need to ensure that appropriate task lighting is available, even if residents have a diagnosis of a dementing disease. Appropriate task lighting would apply, of course, to all types of settings for seniors. Another design issue that would appear to have general application is the need for design professionals to consider more carefully the function of each space. In this study it was evident that a hall that served as an access to the outdoors, in addition to serving as a passageway, needed to be appropriately lit for both functions, and the lighting needed to be age-appropriate.

Another design issue arose from the hall lighting seen in the centres. The variation in the measurements taken along the length of the halls revealed that the lighting levels were uneven on the horizontal plane. In addition, lighting levels were uneven on the vertical plane, based on measurements at face level and floor level. Although such variation is considered relaxing by lighting experts who recommend non-uniform lighting, this runs against the advice of other experts, who suggest uniform lighting for persons with Alzheimer's disease. Uniform lighting will appear to be more institutional, and non-uniform more residential, making choices difficult for design professionals. When the goals of appropriate care and the goals of attractive lighting are in conflict, the care goals should dominate. This means that care providers need to become more knowledgeable about the lighting needs of their clients, because design professionals may not be aware of care goals or they may not be stated in a way that designers find useful.

Whereas daylighting appears to be a good strategy and was effective in both centres in this study, more consideration needs to be given to control of strong daylight. The very wide roof overhang at MPW was effective in doing this and appeared to provide a transition area that allowed residents' eyes to adjust to changes in light as they moved between indoors and out. Another issue is the orientation of the buildings to the sun. The orientation of MPW resulted in the largest bank of windows facing east and west, which appeared to distribute more direct sun through the centre than the orientation of MPN, which placed these main windows to the south and north. Although precepts of energy-saving design hold that buildings should face south to harness solar energy and maximize light exposure, the post-occupancy evaluation at MPN and informal discussions with MPW staff suggested that the orientation of MPW was more liveable for residents. The MPN orientation should have provided its common areas with better daylighting than the orientation at MPW, because southern exposures provide optimal daylighting. However, the common areas were not the areas best used by residents. The living-dining rooms in the houses were the highest use areas in both centres. Thus, given the particular design of these two buildings, the MPW orientation, which resulted in the living-dining rooms having south-facing windows, provided optimal daylighting to the areas most important to residents. In addition, the MPW orientation seemed to be better for outdoor areas. The largest patio at MPN, which faced south, was poorly used because of the intense light and reflection from the cement patio (Milke, 1997). At MPW, the patio was well used. Facing west, it provided areas of sun and shade; only sunny areas were available at MPN.

In conclusion, this study did not provide any strong evidence that the new IESNA age-adjusted lighting recommendations are appropriate for the study population. Residents appeared to interact with each other, their visitors, and with staff in a wide range of lighting conditions. This does not allow one to conclude that all the lighting levels found in the centres are satisfactory for these residents, because they are not apt to complain or to look for better light to look at a

magazine. The study results confirmed suggestions in the literature that extremely bright light should be avoided. The literature suggests that glare is the chief problem for the aged in such conditions. One expert has suggested persons with Alzheimer's disease are psychologically harmed by inadequate lighting because, unable to avoid problem areas, they may endure daily torment. However, that was not the case in this study with the extremely bright light. Residents were all mobile, and they appeared to avoid the hall that had a measured maximum of 31 620 lux. They also were reported by staff to avoid areas that were too poorly lit, like the shuffleboard at MPW. However, direct observations suggested residents did not appear to prefer well-lit areas for their activity, with the possible exception of MPW residents and their apparent preference to linger in their living-dining rooms.

Until the IESNA guidelines are backed by substantial research, Brawley's advice seems apt. She says that as healthcare settings take on a residential appearance, lighting provides one of the most important design elements. It should "increase function, minimize the discomfort and hazards associated with glare, and improve the poor colour rendition of low quality fluorescent light" (Brawley 1997, p. 86). Meeting the minimum IESNA recommendations may satisfy visual requirements, but they do not necessarily satisfy the requirements for non-visual light. The aged, and particularly people suffering from Alzheimer's, require more light for non-visual purposes. Most are not able to go out, thus daylighting in interior spaces should be used, with artificial lighting to supplement when the outdoor light conditions are low. For residents with Alzheimer's disease, the residential feel of a setting is an important part of the milieu that supports their remaining functions. It helps maintain their everyday behaviours. Design professionals will require considerable skill to adequately light the residential settings and still maintain a home-like décor. The effort should be worthwhile. There appears to be considerable interest in such residential settings, judging by the 200-300 professionals a year who visit MPN and MPW from places in Canada from the Maritimes to Victoria, and from Australia, Hong Kong, the Ukraine, United States, and Thailand. All have said they are in various planning stages of similar centres.

6.2 Next Steps

Further lighting research should be done with persons who have Alzheimer's disease. An ABAB research design of lighting level changes would provide more definitive information than the correlational design of the present study. However, if this study were replicated researchers should seek more appropriate elderly raters to serve as proxy judges of lighting levels than residents' family members. In addition, a researcher experienced in communicating with this population could ask residents simple straightforward questions about lighting, pacing questions appropriately and using concrete, rather than abstract terms. Throughout the time residents with Alzheimer's disease remain verbal, most seem able to indicate whether they like or dislike something. Their answers might not all be useful, but it has been demonstrated that some with this diagnosis can provide relevant comments (Wigod 1999; Hutchinson and Jensen 1980; Grober et al. 1985; Nebes and Boller 1986; Depuis and Neufeldt 1996; Phinney 1998). Residents' comments could supplement the assessments of proxies and staff members. If objective measurements are done of lighting levels on two centres, it would be better to divide the measurements so half are done in each centre on each day, to avoid taking measurements on days with dissimilar natural lighting, although this may not guarantee equivalent natural light conditions for both locations.

Research is needed on the level of lighting required to support facial recognition in the aged so that age-adjusted recommendations can be developed. In light of the confirmation by IESNA that past guidelines were inappropriate for the aged, researchers and organizations operating all types of settings for seniors need to evaluate the lighting currently being provided in such centres.

The next steps for *The* Capital Care *Group*, the operator of the two settings in this study, involves improving lighting levels in MPN. No doubt even more careful consideration of lighting will go into building its next Alzheimer centre to ensure that exterior entrances have areas where residents' eyes can accommodate to major changes in light levels. The organization might also consider altering the interior colour scheme, considering the evidence that the aged have problems discriminating colour on the blue/yellow axis. Evidently problems are exacerbated when the colours are pale, as they typically are on walls. It seems unlikely that the residents can distinguish between the Blue and Green houses in the centres in the study. Colours need to be thought of in terms of figure-ground relationships. Contrasts such as light entryway: dark doorjamb; light floor: dark furniture, are advocated (Hiatt 1978).

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APPENDIX A
RECOMMENDED LIGHTING LEVELS FROM THE GERONTOLOGICAL LITERATURE

For several decades, a number of design professionals working with the aged have challenged the lighting standards used in settings for aged persons, saying the standards were inappropriately low (Brawley 1977; Noell 1992). The lighting standards were considered to have been "on the wrong track" for the aged (Noell 1992, p. 68). The recommendations for aged persons, now acknowledged to be only rough estimates of their actual illuminance needs, had been developed by the Illuminating Engineering Society of North America (IESNA) using subjects aged 20-30. However, the gerontological literature indicated that the visual systems of the young and old react very differently. For example, some authorities suggest that to see as well as a 20-year old, a 60-year old person requires about 2.5 times as much light with an identical light source (Guth 1957). Lighting recommendations for those aged 20-30 would not be expected to be appropriate for individuals 60 years and older. The following table represents some of the lighting recommendations found in the gerontological literature.

Table A-1
Recommended Lighting Levels for Long Term Care Centres*
Measurements in lux

		Authority		
Space	**Activity**	**Hiatt (1991)**	**Brawley (1997)**	**Other**
Activities room	Crafts, games, reading	500 – 1000	300 – 500	
Bathroom, tub room, shower area	Grooming	500 – 1000	300 – 600	
Beauty Salon	Grooming	500 – 1000	500	
Bedroom, bed-sitting room	Leisure activities, reading, sleeping	500 – 1000	300 – 750	
Chapel	Meditation	500 – 1000	300	
Dining areas	Dining, crafts, games, reading	500 – 600	500	
Examination area	Medical tasks		300 – 1000	750 – 1000**
Halls, doorways to rooms	Room & facial recognition	500 – 1000	300	
Kitchen area	Food preparation, reading		300 – 500	
Library	Reading, writing	500 – 1000		
Telephone areas	Reading, writing	500 – 1000	300 – 500	

* Older persons who use magnifiers or corrective lenses require higher levels of lighting.
** Benya (1994) some medical tasks require accurate colour rendering.

APPENDIX B
ROOM SIZES IN THE TWO CENTRES

The following table compares the sizes of the rooms and halls examined in the study. Where no comparable area exists at MPW, this has been identified. When the centre had more than one of the designated rooms the range of room sizes is listed.

Table B-1
Comparison of Room Sizes in McConnell Place North and McConnell Place West
(In square feet)

Location	MPN	MPW
Total Building Square Footage	24 725	23 864
Common Areas		
Beauty Salon	231.47	231.52
Craft Room	271.10	146.06
Entertainment Room	250.00	241.18
Family Dining Room	296.55	335.80
Great Room	578.65	578.18
Horticulture Room/Area	536.53	419.46
Library Seating	683.24	683.85
Music Room	205.92	*
TV Area	390.00	348.63
Back Patio Hall	539.62	322.00
Front Street Hall	707.96	641.00
Green Area Hall	477.95	461.43
Rose Area Hall	484.00	476.52
House Areas		
Green Living-Dining	428.20	477.47
Rose Living-Dining	431.02	483.55
Blue Living-Dining	400.00	432.00
Green Kitchen	157.95	185.91
Rose Kitchen	157.95	185.91
Blue Kitchen	157.95	178.00
Green Laundry	111.06	93.32
Rose Laundry	87.92	93.32
Blue Laundry	84.00	101.00
Green Bedroom Hall	529.92	574.50
Rose Bedroom Hall	529.92	574.50
Blue Bedroom Hall	529.92	574.50
Single Resident Bedroom	138.00 –142.90	137.90 – 142.90
Double Resident Bedroom	431.90	417.37
Single Resident Bathroom	32.95 - 44.35	32.95 – 44.54
Double Resident Bathroom	37.38	48.91
Tubroom	61.24 – 61.36	61.24

*MPW does not have a Music Room.

APPENDIX C

SELECTED ROOM FINISHES IN THE TWO CENTRES

The following table provides a room-by-room comparison of wall and floor finishes in MPN and MPW. As noted above, resident houses had colour themes, blue, rose, and green to aid residents in wayfinding. The finishes listed below were designed to complement the colour schemes of the houses. In so far as possible, the colours and wallpapers at MPW, the centre that opened in 1998, were selected to match MPN, which opened in 1995. Observers noted that the rose, blue, and green paint colours used on baseboards and door framing used in MPW were less "greyed" than the corresponding hues in MPN. The difference made the Rose House doors at MPW noticeably "rosier" than the Rose House at MPN but differences were subtle in the Green and Blue Houses. The houses took their names from the colour scheme used for them. Bedroom and service doors, chair rails, and picture rails within the houses were painted the name colour. Colour-coded areas were considered a memory aide for residents.

Table C-1
Comparison of Selected Room Finishes in McConnell Place North and McConnell Place West

Location	MPN	MPW
Common Areas		
Beauty Salon		
Wall Covering	• Paint, #967 Off-White Benjamin Moore	• Paint, #967 Off-White Benjamin Moore
Flooring	• Vinyl Flooring, "Coordinates" – Aquamarine Mist	• Vinyl Flooring, "Coordinates" – Aquamarine Mist
Craft Room		
Wall Covering	• Fabric Wall Covering, "Teck Wall 1000" – Spray Mist, "Bentley" – Middleberry	• Paint, #967 Off-White Benjamin Moore
Flooring	• Broadloom Carpet, "Half Moon Bay" – Jamaica Bay	• Vinyl Flooring, "Coordinates" – Aquamarine Mist
Entertainment Room		
Wall Covering	• Vinyl Wallcovering "Kobe" – Blue Jade, "Kinney"	• Vinyl Wallcovering "Kobe" – Blue Jade
Flooring	• Broadloom Carpet, "Wild Dunes" – Georgian Sunset	• Broadloom Carpet, "Wild Dunes" – Georgian Sunset • Paint, #1158 Medium Taupe Benjamin Moore

Location	MPN	MPW
Family Dining Room Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry, "Kobe" – Blue Jade • Vinyl Flooring, "Coordinates" – Aquamarine Mist	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Vinyl Flooring, "Coordinates" – Aquamarine Mist
Great Room Wall Covering Flooring	• Paint, #1158 Medium Taupe Benjamin Moore/ Vinyl Wallcovering, "Bentley" – Cloud • Broadloom Carpet, "Wild Dunes" – Georgian Sunset, "Sawgrass" Laguna border	• Paint, #1158 Medium Taupe Benjamin Moore/ Vinyl Wallcovering, "Charing Cross" – Musk • Broadloom Carpet, "Wild Dunes" – Georgian Sunset, "Sawgrass" Laguna border
Horticulture Room/Area Wall Covering Flooring	• Paint, #067 Off-White Glidden, #1265 Rose Glidden • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay
Library Seating Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Sawgrass" – Laguna • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Sawgrass" – Laguna • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border
Music Room Wall Covering Flooring	• Paint, #967 Off-White Glidden, #678 Green Glidden • Broadloom Carpet, "Sawgrass" - Laguna	*
TV Area Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay

Location	MPN	MPW
Back Patio Hall Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border
Front Street Hall Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border
Green Area Hall Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay,	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay
Rose Area Hall Wall Covering Flooring	• Vinyl Wallcovering, "Bentley" – Middleberry • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border	• Vinyl Wallcovering, "Fenwick" – Pale Taupe • Broadloom Carpet, "Half Moon Bay" – Jamaica Bay, "Sawgrass" – Laguna border
House Areas		
Green Living-Dining Wall Covering Flooring	• Paint, #678 Green Glidden • Vinyl Wallcovering, "Kobe" – Blue Jade, "Kinney" • Vinyl Flooring, "Coordinates" – Aquamarine Mist	• Paint, #677 Green Glidden • Vinyl Wallcovering, "Kobe" – Blue Jade • Vinyl Flooring, "Coordinates" – Aquamarine Mist
Rose Living-Dining Wall Covering Flooring	• Paint, #1265 Rose Glidden • Vinyl Wallcovering, "Kobe" – Dusty Plum, "Itonics" – Weave • Vinyl Flooring, "Coordinates" – Mauve Dusk	• Paint, #1273 Rose Glidden • Vinyl Wallcovering, "Kobe" – Dusty Plum, "Fenwick" – Rose Tan • Vinyl Flooring, "Coordinates" – Mauve Dusk

Location	MPN	MPW
Blue Living-Dining Wall Covering Flooring	• Paint, #1679 Blue Glidden • Vinyl Wallcovering, "Kobe" – Shadow, "Borden" • Vinyl Flooring, "Coordinates" – Blue Horizon	• Paint, #1678 Blue Glidden • Vinyl Wallcovering, "Kobe" – Shadow, "Fenwick" – Blue Haze • Vinyl Flooring, "Coordinates" – Blue Horizon
Green Kitchen Wall Covering Flooring	• Paint, #678 Green Glidden • Vinyl Wallcovering, "Bentley" – Jade • Vinyl Flooring, "Coordinates" – Aquamarine Mist	• Paint, #677 Green Glidden • Vinyl Wallcovering, "Charing Cross" – Pongee • Vinyl Flooring, "Coordinates" – Aquamarine Mist
Rose Kitchen Wall Covering Flooring	• Paint, #1265 Rose Glidden • Vinyl Wallcovering, "Bentley" - Cloud • Vinyl Flooring, "Coordinates" – Mauve Dusk	• Paint, #1273 Rose Glidden • Vinyl Wallcovering, "Charing Cross" – Musk • Vinyl Flooring, "Coordinates" – Mauve Dusk
Blue Kitchen Wall Covering Flooring	• Paint, #1679 Blue Glidden • Vinyl Wallcovering, "Bentley" – Blue Sky • Vinyl Flooring, "Coordinates" – Blue Horizon	• Paint, #1678 Blue Glidden • Vinyl Wallcovering, "Charing Cross" – Fresco • Vinyl Flooring, "Coordinates" – Blue Horizon
Green Laundry Wall Covering Flooring	• Paint, #967 Off-White Glidden • Paint, #678 Green Glidden • Vinyl Flooring, "Coordinates" – Aquamarine Mist	• Paint, #967 Off-White Benjamin Moore • Paint, #677 Green Glidden • Vinyl Flooring, "Coordinates" – Aquamarine Mist
Rose Laundry Wall Covering Flooring	• Paint, #967 Off-White Glidden • Paint, #1265 Rose Glidden • Vinyl Flooring, "Coordinates" – Mauve Dusk	• Paint, #967 Off-White Benjamin Moore • Paint, #1273 Rose Glidden • Vinyl Flooring, "Coordinates" – Mauve Dusk

Location	MPN	MPW
Blue Laundry Wall Covering Flooring	• Paint, #967 Off-White Glidden • Paint, #1679 Blue Glidden • Vinyl Flooring, "Coordinates" – Blue Horizon	• Paint, #967 Off-White Benjamin Moore • Paint, #1678 Blue Glidden • Vinyl Flooring, "Coordinates" – Blue Horizon
Green Bedroom Hall Wall Covering Flooring	• Paint, #678 Green Glidden • Vinyl Wallcovering, "Bentley" – Jade • Broadloom Carpet, "Wild Dunes" – Pinehurst Green	• Paint, #677 Green Glidden • Vinyl Wallcovering, "Charing Cross" – Pongee • Broadloom Carpet, "Wild Dunes" - Pinehurst Green
Rose Bedroom Hall Wall Covering Flooring	• Paint, #1265 Rose Glidden • Vinyl "Wallcovering, "Bentley" – Cloud • Broadloom Carpet, "Wild Dunes" – Georgian Sunset	• Paint, #1273 Rose Glidden • Vinyl Wallcovering, "Charing Cross" – Musk • Broadloom Carpet, "Wild Dunes" – Georgian Sunset
Blue Bedroom Hall Wall Covering Flooring	• Paint, #1679 Blue Glidden • Vinyl Wallcovering, "Bentley" – Blue Sky • Broadloom Carpet, "Wild Dunes" – Swiss Alps	• Paint, #1678 Blue Glidden • Vinyl Wallcovering, "Charing Cross" - Fresco • Broadloom Carpet, "Wild Dunes" – Swiss Alps
Resident Bedroom Wall Covering Flooring	• Paint, #967 Off-White Glidden • Congoleum Endurance "Society Hill"	• Paint, #967 Off-White Benjamin Moore • Congoleum Endurance "Society Hill"
Resident Bathroom Wall Covering Flooring	• Ceramic Wall Tile, Dal White • Seamless epoxy, Desco "Quartzite" #016	• Ceramic Wall Tile, Dal White • Seamless epoxy, Desco "Quartzite" #016
Tubroom Wall Covering Flooring	• Ceramic Wall Tile, Dal White • Seamless epoxy, Desco "Quartzite" #016	• Ceramic Wall Tile, Dal White • Seamless epoxy, Desco "Quartzite" #016

*MPW does not have a Music Room.

APPENDIX D

WINDOW DISTRIBUTION IN THE TWO CENTRES

The following table lists and compares window sizes and allotments by room and area for each centre. A description of the window specifications is included in Appendix E. There were 13 public or shared rooms (or areas) at MPN and 11 at MPW that did not have windows, although many were situated or had French doors, often combined with interior windows, that allowed natural light to enter. In addition, the resident ensuite bathrooms had no windows. There were 30 such private bathrooms attached to single bedrooms, and three attached to double bedrooms in each centre. Each bedroom had an ensuite bathroom.

Some of the most notable differences in window distribution between the two centres were the addition of a second large window to the MPW Green living-dining room, and a glass block window to the MPW tubrooms. In addition, a design change in the Great Room at MPW saw skylights, with a mechanism to bounce light across the room, being used instead of the clerestory windows used at MPN.

Table D-1
Comparison by Location of McConnell Place North and McConnell Place West Window Allocation and Window Sizes

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes** (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**
Common Rooms Beauty Salon	• One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	31.5	5.6	• One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	31.5	4.4
Craft Room	• Two 5'4" x 3'8" interior windows, heavily frosted	39.1	8.2	None		

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes (Exterior unless noted)**	**Sq. Ft.**	**% of Wall Space**
Entertainment Room	• One 5'10" x 4'7" (comes with 1'2" opening quarter-window) • One 5'3" x 2' interior window in a French Door • One 5'3" x 1'1" interior window	42.9	8.2	• One 5'10" x 5'11" • Two 5'3" x 2' interior windows in two French Doors • One 4'5" x 1'10" interior window in a fire door	63.6	12.2
Family Dining Room	• One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows • One 3' x 2'6" interior window	39.0	6.4	• One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows • Two 5'3" x 1'7" interior windows on two French Doors	48.1	6.6
Great Room	• Six 7' x 3' (Clerestory windows)	126.0	5.3	• Ten 5'11" x 5'1 3/8" skylights	302.6	14.8
Horticulture Room/Area	• Four 5'10" x 6'11" (comes with 1'2" opening quarter-window) • Two 5'3" x 2' interior windows in French Doors • One 5'2" x 1'10" window in exit door	191.9	22.4	• One 5'10" x 6'10" (comes with 1'2" opening quarter-window) • One 5'1" x 1'10" window in exit door	49.2	12.1
Library Seating	None			None		

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes** (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**
Music Room	• Two 5'3" x 2' interior windows in French Doors	21.0	4.5	*		
TV Area	• One 5'11" x 6'10" (comes with 1'2" opening quarter-window) • One 5'2" x 1'10" window in exit door	49.9	16.4	• One 5'10" x 6'10" (comes with 1'2" opening quarter-window) • One 5'1" x 1'10" window in exit door	49.2	12.6
Back Patio Hall	• Five 5'11" x 6'10" • Two 5'2" x 1'10" windows in exit doors <u>Beauty Salon</u> • One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	252.6	32.7	• Four 5'10" x 6'10" • One 5'1" x 2'4" window in exit door <u>Beauty Salon</u> • One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	202.8	28.4

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes (Exterior unless noted)**	**Sq. Ft.**	**% of Wall Space**
Front Street Hall	• Seven 5'11" x 6'10" • One 5'11" x 6'10" (comes with 1'2" opening quarter-window) • One 5'2" x 1'10" window in exit door <u>Family Dining Room</u> • One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	332.9	27.0	• Four 5'10" x 6'10" • Seven 5'9" x 3' 1 ½" <u>Family Dining Room</u> • One 5'3" x 2' interior window in a French Door • Two 5'3" x 2' interior windows	316.7	40.3
Green Area Hall	• Five 5'11" x 6'10" • One 5'2" x 1'10" window in exit door <u>Music Room</u> • Two 5'3" x 2' interior windows in French Doors <u>Horticulture Room</u> • Two 5'3" x 2' interior windows in French Doors	253.7	27.8	• Five 5'10" x 6'10" • One 5'9" x 2'9" • One 5'1" x 1'10" window in exit door	224.4	25.5
Rose Area Hall	None			None		

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes** (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**
House Areas Green Living-Dining	• One 5'11" x 6'10" (comes with 1'2" opening quarter-window) • One 5'10" x 3'3" (comes with 1'2" opening quarter-window) • One 2' x 3'6" • One 7' x 3'6" • One 5'2" x 1'10" window in exit door	98.1	12.4	• Three 5'10" x 6'10" (comes with 1'2" opening quarter-window)	119.6	16.5
Rose Living-Dining	• One 5'11" x 6'10" (comes with 1'2" opening quarter-window) • One 5'10" x 3'3" (comes with 1'2" opening quarter-window) • One 2' x 3'6" • One 7' x 3'6" • One 5'2" x 1'10" window in exit door	98.1	12.2	• Two 5'10" x 6'10" (comes with 1'2" opening quarter-window)	79.7	10.7

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	**Sq. Ft.**	**% of Wall Space**	**Windows and Sizes (Exterior unless noted)**	**Sq. Ft.**	**% of Wall Space**
Blue Living-Dining	• One 5'11" x 6'10" (comes with 1'2" opening quarter-window) • One 5'10" x 3'3" (comes with 1'2" opening quarter-window) • One 2' x 3'6" • One 7' x 3'6" • One 5'2" x 1'10" window in exit door	98.1	12.3	• Two 5'10" x 6'10" (comes with 1'2" opening quarter-window)	79.7	11.2
Green Kitchen	• One 5' x 3'5"	17.1	5.9	• One 3'3" x 4'10" (half-window opening)	15.7	4.5
Rose Kitchen	• One 5' x 3'5"	17.1	5.9	• One 3'3" x 4'10" (half-window opening)	15.7	4.5
Blue Kitchen	• One 5' x 3'5"	17.1	5.9	• One 3'3" x 4'10" (half-window opening)	15.7	4.2
Green Laundry	None			None		
Rose Laundry	None			None		
Blue Laundry	None			• One 3'3" x 4'10" (half-window opening)	15.7	4.5
Green Bedroom Hall	• One 5'2" x 1'10" window in exit door • One 5'7" x 10" interior window	14.2	0.8	• One 5'1" x 1'10" window in exit door • One 5'7" x 8.5" interior window	13.3	0.7

Location	MPN			MPW		
	Windows and Sizes (Exterior unless noted)	Sq. Ft.	% of Wall Space	Windows and Sizes (Exterior unless noted)	Sq. Ft.	% of Wall Space
Rose Bedroom Hall	• One 5'2" x 1'10" window in exit door • One 5'7" x 10" interior window	14.2	0.8	• One 5'1" x 1'10" window in exit door • One 5'7" x 8.5" interior window	13.3	0.7
Blue Bedroom Hall	• One 5'2" x 1'10" window in exit door • One 5'7" x 10" interior window	14.2	0.8	• One 5'1" x 1'10" window in exit door • One 5'7" x 8.5" interior window	13.3	0,7
Single Resident Bedroom	• One 4'7" x 5'9" (comes with 1'2" opening quarter-window)	26.3	7.1	• One 4'7" x 5'9" (comes with 1'2" opening quarter-window)	26.3	7.1
Double Resident Bedroom	• Three 4'7" x 5'9" (comes with 1'2" opening quarter-window)	78.9	8.3	• Three 4'7" x 5'9" (comes with 1'2" opening quarter-window)	78.9	7.9
Resident Bathroom	None			None		
Tubrooms (1 per house)	None			• One 3'10" x 2'6" glass block window	9.6	3.6

* MPW does not have a Music Room

APPENDIX E

WINDOW GLAZING SPECIFICATIONS FOR McCONNELL PLACE NORTH AND McCONNELL PLACE WEST

Both MPN and MPW have double-pane low-emissivity, or Low-E, windows. That is, the glass surfaces inside the cavities of the windows are coated with a special transparent film that allows the sun's heat, or infrared radiation, to pass easily inwards. The coating, however, acts like a mirror for infrared radiation passing outwards, inhibiting heat loss. To improve insulation, some Low-E windows have inert gasses such as Argon or Krypton added between window panes. This reduces convection heat loss. MPN but not MPW, had Argon filled windows. Another benefit of low-E windows is considered to be the reduction of the ultraviolet radiation (UV) portion of sunlight. The windows are said to reduce UV damage by 60% to 90%. UV is responsible for sunburn and contributes to fabric fading and artwork damage.

The table below provides the specifications for the windows installed at MPN and MPW. Some terms require explanation. The U-value refers to UV light blockage or transmittance; that is, the percentage of UV radiation that passes through the glazing. The U-value is most important where heating costs are a concern, as costs are in Edmonton where the two centres in this study are located. The difference between indoor and outdoor temperatures is usually considerably higher in winter than in summer. The U-value is related to the conducted heat gain or heat loss through the windows. A lower U-value indicates a better insulating performance. A window system with a U-value of 0.35 outperforms a system with a U-value of 1.1.

Table E-1

Comparison By Location of Glazing Specifications at McConnell Place North and McConnell Place West

	Type	U-Value	Shading Coefficient	Ultraviolet Light Transmission	Visible Light Transferrance
MPN	Dual 1-Low E Argon Fill	0.26	0.70	39%	75%
MPW	Dual 1-Low E (No Argon Fill)	0.28	0.79	26%	72%

The web site for the Pacific Energy Center reports:

> In cold weather, a single pane window with a high U-value will quickly reach nearly the same low temperature as the outside air. Persons sitting inside near that window will likely feel chilled, even with a warm indoor air temperature, due to the body's heat loss by radiation to that cold glass surface. Additionally, room air is chilled upon contact with the cold glass and falls along the window, creating a cold "down" draft. Finally, cold surfaces have a higher likelihood for condensation than warm surfaces. The lower the U-value, the more closely the glass temperature will match room temperature, reducing condensation possibilities (Pacific Energy Center Website, May 28, 1999).

The shading coefficient is a measure of a glass product's capability to lower solar heat gain. The lower the coefficient, the less solar heat acquired indoors. Clear glass is the reference point for the shading coefficient, with 1/8-inch clear glass having a coefficient of 1.00. Coefficients are usually less than 1.00 because most glass lowers solar heat gain more than the base reference.

Visible light transference is related to glare. If visible transmittance is high, a glare problem may be introduced. The window and the area immediately adjacent may be far brighter than the surroundings resulting in high contrasts that are difficult for the eyes to handle, particularly aged eyes. The web site for the Pacific Energy Center reports:

> Low transmittance glazing, while reducing glare, creates "gloomy" interiors, diminished view, and little daylight. Visual comfort can be achieved with high transmittance glazing through careful sizing and placement of windows, light colored interior surfaces, movable window coverings, light diffusing deep sills and baffles, among other solutions (Pacific Energy Center Website, May 28, 1999).

Some researchers have expressed concern about low transmittance glazing, because while they may save energy, there is a reduced amount of daylight and changes to the spectral quality of that light; that is, there is less of the blue light portion that would make it harder for the aged to discriminate blue colours from the green colours.[1]

[1] Personal communication via e-mail from V. Salares, October 5, 1999

APPENDIX F

COLOR TEMPERATURE ATTRIBUTES AND LIGHTING FIXTURES IN THE TWO CENTRES

An important characteristic of lighting is the impact the light source has on the colour of objects. One measurement of this is colour temperature, which refers to the colour appearance of the light itself. The light's colour, that is, the value of its temperature, is reported in degrees Kelvin (K), an absolute thermal scale with degree intervals equal to those of the Celsius scale. The standard temperature reading for interior white light is 3200 degrees Kelvin.[2] Warm tones for lighting are expressed from 0 to about 3000K, neutral tones from approximately 3000K to 4000K, and cool tones from approximately 4000K to 10000K (Energy Outlet Website, May 26, 1999). A candle flame has a colour temperature of 1800K. The light from a 100-watt incandescent lamp is whiter and has a colour temperature of 2700K.

The colour-rendering index (CRI) describes another characteristic of lighting. The CRI is a relative measure of the shift in surface colour of an object when lit by a particular lamp, compared to how the object would appear under a reference light source. Incandescent lamps (warm light sources) and natural daylight (a cool light source) are commonly used as references. Both have a CRI of 100, the highest index possible. Warmer colour temperatures for fluorescent bulbs are recommended as a better match with incandescent lamps (Energy Outlet Website, May 26, 1999). Light sources from the red/orange/yellow side of the spectrum are described as warm, and those toward the blue end are referred to as cool. The higher the CRI of the light source, the truer it is considered to render colour (Energy Outlet Website, May 26, 1999).

Maintaining a residential appearance was an important goal for the designers of MPN and MPW. The lighting was intended to appear like that typically found in homes in residential communities. The light bulbs at both MPN and MPW were made up of a combination of incandescent and fluorescent bulbs that had a colour temperature range up to 3500K, and a CRI range of 55-95.

Because there was a concern that residents would rise at night to go to the bathroom and not be able to find their way, all ensuite bathrooms were provided with 24-hour lights; that is, no "off" switch was provided. Other 24-hour lights were provided in hallways to ensure that a resident who rose and walked at night would remain oriented to the centre. Again no "off" switches were provided. Wandering is a well-known characteristic of persons diagnosed with Alzheimer's disease. Because they are apt to move toward brighter lights, the brighter lights in the centre at night should lead the wanderer to a location where staff will be found. Red, lighted "exit" signs are at, and near, all exit points (doors to the secure courtyard are electronically locked at night). The following table identifies lighting fixture complements by room and hall, and compares these allocations by site. A symbol identifies 24-hour lights.

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[2] The Kelvin scale was developed by heating a carbon filament (a "black body") which Lord Kelvin considered to totally light absorbing (i.e. a theoretical object with emissivity = 1.0). He observed that the hotter the carbon filament became the bluer the radiated light became, and as the filament cooled down the radiated light became redder. When the filament was heated to 3,200 degrees centigrade (from absolute zero), the carbon filament emitted a fairly white light, which became the "standard" temperature reading for interior white light.

Table F-1

Comparison of Lighting Fixtures at McConnell Place North and McConnell Place West

Numbers designate luminaires (complete lighting units, lamps, that is bulbs or tubes, parts designed to distribute and protect the light and connection to power).

The numbers in brackets designate the number of lumens per light source.[3]

Location	MPN	MPW
Common Areas		
Beauty Salon	• 4 recessed 2' x 4' fluorescent fixtures (2800 lumens x 8 lamps)	• 4 recessed 2' x 4' fluorescent fixtures (2800 lumens x 8 lamps)
Craft Room	• 3 recessed 2' x 4' recessed fluorescent fixtures (2800 lumens per lamp x 6 lamps)	• 2 recessed 2' x 4' fluorescent fixtures (2800 lumens x 4 lamps)
Entertainment Room	• 5 recessed downlights (685 lumens per lamp) • 2 wall sconces (860 lumens per lamp) • 1 table lamps (860 lumens per lamp)	• 8 recessed downlights (1800 lumens per lamp)
Family Dining Room	• 1 ceiling mounted fixture (860 lumens x 2 lamps) • 1 ceiling mounted fixture (chandelier; 860 lumens x 5 lamps) • 3 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 1 x 23" fluorescent light strips with solid reflector (1300 lumens per lamp) • 2 wall mounted sconces (860 lumens per lamp)	• 1 ceiling mounted fixture (chandelier; 820 lumens x 5 lamps) • 11 recessed downlights (1800 lumens per lamp) • 2 x 48" fluorescent lamp strips with solid reflector (2800 lumens per lamp) • 3 x 23" fluorescent lamp strips with solid reflector (1300 lumens per lamp)
Front Alcove	• 14 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) ‡	*

[3] Lumen is the unit that expresses the total quantity of light given off by a source, regardless of direction. A lumen is defined as the amount of light falling on a surface of one square foot, every point of which is one foot away from a source of one candlepower.

Location	MPN	MPW
Great Room	• 6 ceiling mounted pendant light fixtures (860 lumens per lamp) • 12 wall mounted sconces (860 lumens per lamp) • 4 recessed downlights (1800 lumens per lamp) ‡	• 6 ceiling mounted pendant lights (3400 lumens per lamp) • 4 wall mounted sconces (695 lumens per lamp) • 14 x 48" fluorescent lamp strips with solid reflector (2800 lumens per lamp) • 2 ceiling mounted fixtures (custom built chandelier; 2 48" fluorescent bulbs per chandelier, 2880 lumens per lamp) • 3 recessed downlights (1800 lumens per lamp) • 2 recessed downlights (1800 lumens per lamp) ‡
Horticulture Room/Area	• 6 recessed 2' x 4' fluorescent fixtures (2800 lumens x 12 lamps) • 1 x 48" fluorescent lamp strip with solid reflector (2800 lumens per lamp)	• 4 recessed downlights (1800 lumens per lamp) • 1 recessed downlight (1800 lumens per lamp) ‡ • 7 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp)
Library Seating	• 4 ceiling mounted fixtures (chandeliers) (860 lumens x 5 lamps per fixture) • 4 recessed downlights (860 lumens per lamp) • 2 wall mounted sconces (860 lumens per lamp) • 2 table lamps (860 lumens per lamp)	• 2 ceiling mounted fixtures (chandeliers; 820 lumens x 5 lamps per fixture) • 22 recessed downlights (1800 lumens per lamp) • 11 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp)
Music Room	• 4 potlights (685 lumens per lamp) • 2 wall mounted sconces (860 lumens per lamp)	*
TV Area	• 9 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) ‡ • 1 recessed downlight (1800 lumens per lamp) ‡ • 1 table lamp (860 lumens per lamp)	• 5 recessed downlights (1800 lumens per lamp) • 1 recessed downlight (1800 lumens per lamp) ‡ • 10 x 48" fluorescent lamp strips with solid reflector (2800 lumens per lamp)

Location	MPN	MPW
Back Patio Hall	• 16 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) ‡	• 15 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 7 recessed downlights (1800 lumens per lamp) • 3 recessed downlights (1800 lumens per lamp)‡
Front Street Hall	• 8 recessed downlights (1800 lumens per lamp)‡	• 10 recessed downlights (1800 lumens per lamp) • 3 recessed downlights (1800 lumens per lamp)‡ • 8 x 48" fluorescent bulbs (2800 lumens per lamp)
Green Area Hall	• 10 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp)‡ • 1 recessed downlight (1800 lumens per lamp)‡	• 14 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 6 recessed downlights (1800 lumens per lamp) • 1 recessed downlight (1800 lumens per lamp)‡
Rose Area Hall	• 9 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) ‡ • 1 recessed downlight (1800 lumens per lamp) ‡	• 9 x 48" fluorescent lamp strips with solid reflector (2800 lumens per lamp) • 6 recessed lights (1800 lumens per lamp) • 1 recessed downlights (1800 lumens per lamp)‡
House Areas Living-Dining Rooms	<u>All Houses</u> • 4 wall mounted sconces (860 lumens per lamp) • 8 recessed downlights (860 lumens per lamp) <u>Rose and Green Houses</u> • 1 table lamp (860 lumens per lamp)	<u>Blue House</u> • 4 wall mounted sconces (1800 lumens per lamp) • 16 recessed downlights (1800 lumens per lamp) <u>Rose and Green Houses</u> • 4 wall mounted sconces (1800 lumens per lamp) • 18 recessed downlights (1800 lumens per lamp)

Location	MPN	MPW
Kitchens (All houses)	• 2 recessed downlights (1800 lumens per lamp) • 2 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 2 x 23" fluorescent light strips with solid reflector (1300 lumens per lamp) • 2 ceiling mounted fixtures (1800 lumens per lamp) • 1 wall mounted sconce (860 lumens per lamp) • 1 table lamp (860 lumens per lamp)	<u>Green and Rose Houses</u> • 2 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 3 x 23" fluorescent light strips with solid reflector (1300 lumens per lamp) • 9 recessed downlights (1800 lumens per lamp) • 1 recessed downlight (1800 lumens per lamp)‡ <u>Blue House</u> • 3 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 2 x 23" fluorescent light strips with solid reflector (1300 lumens per lamp) • 8 recessed downlights (1800 lumens per lamp) • 1 recessed downlight (1800 lumens per lamp)‡
Laundry Rooms (All houses)	• 2 x 48" ceiling mounted fluorescent light (2800 lumens per lamp) • 4 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp)	<u>Green and Rose Houses</u> • 2 x 48" ceiling mounted fluorescent light (2800 lumens per lamp) • 4 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) <u>Blue House</u> • 2 x 48" ceiling mounted fluorescent light (2800 lumens per lamp) • 2 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 2 x 23" fluorescent light strips with solid reflector (1300 lumens per lamp)

Location	MPN	MPW
Bedroom Halls (All houses)	• 6 ceiling mounted fixtures (1800 lumens per lamp) • 4 x 48" fluorescent light strips with solid reflector (2800 lumens per lamp) • 7 wall mounted sconces (400 lumens per lamp) ‡	• 13 recessed downlights (1800 lumens per lamp) • 6 recessed downlights (1800 lumens per lamp)‡ • 1 ceiling mounted fixture (1825 lumens per lamp)
Tubrooms (All houses)	• 1 x 48" wall mounted fluorescent light (2800 lumens per lamp)	• 1 x 48" wall mounted fluorescent light (2800 lumens per lamp)
Resident Bedroom	• 1 ceiling mounted fixture (860 lumens x 2 lamps) • 1 table lamp (860 lumens per lamp)	• 1 ceiling mounted fixture (1500 lumens per lamp) • 1 table lamp (860 lumens per lamp)
Resident Bathroom	• 1 x 48" wall mounted fluorescent light (2800 lumens per lamp) • 1 recessed downlight (860 lumens per lamp) ‡	• 1 x 48" wall mounted fluorescent light (2800 lumens per lamp) • 1 recessed downlight (900 lumens per lamp)‡

* MPW does not have a music room or the equivalent of the front alcove. The front alcove is not discussed or included in any other tables because it was not mentioned in the responses to the staff or family survey and no one was observed using the space.

‡ Light is on 24 hours per day.

APPENDIX G

BUILDING AND ORIENTATION FEATURES FOR McCONNELL PLACE NORTH AND McCONNELL PLACE WEST

Building and Orientation Features - McConnell Place North

The first centre, MPN, was built in 1995. Its main door faced the street on the north, which facilitated construction of the driveway to provide vehicle access to the main door. The building itself was 24 725 sq. ft., with 1675 sq. ft. allocated for administration purposes, and the remainder for resident use. A shared common area linked three residential wings of the centre, referred to as houses. These areas were colour-coded to help with wayfinding (Blue, Rose and Green Houses, Figure 1). Each house was self-contained, with a kitchen, living-dining room, laundry, and tubroom. There were 10 private and one semi-private bedrooms per house, for a total of 36 beds for the centre, with each bedroom having an ensuite bathroom. There were 13 special purpose areas or rooms in the common area that joined the three houses together. The large number of doors from the residents' portion of the centre were part of the "wandering pathways" that are a feature of well-designed Alzheimer care centres. All doors led to patios and courtyard areas in the secured yard, which were linked by cement paths that led back to the doors.

The U-shaped driveway, with two adjacent parking areas for visitors and staff, as well as landscaped and grassed areas, was located in front of the building. This provided a large rear courtyard and garden area that backed onto city parkland and the grassed playing fields of three schools. A pedestrian walkway along one side of the property separated the centre from a residence for seniors. There were no buildings that shaded its windows or any part of its gardens at the time of the study. The trees throughout the property were still relatively small and did not have dense branching. The only tree close enough to provide much shade across a window of the common area was an evergreen to the north. It was approximately eave height.

With the building's north and south orientation, the morning sun came in through an east-facing window wall just outside the door of the residential wing referred to as the Green house. This area on the north side of the building had a number of easy chairs for residents (with light meter readings between 516-523 lux, Table 5, and ambient light of 644 lux, Table 2).

In an earlier observational study, one resident of the Green house said she wanted to be out by the East window because "it is so dark in there," pointing toward the Green living-dining room (occurred June 26, 1996; Milke, 1997). The light meter readings in this study indicated that task lighting in this living-dining room ranged from 105 to 190 lux. Past observations indicated that residents preferred to sit directly in the morning sunshine in this Green area hall. For example, in April 1996, residents from the Green house were seen moving side-chairs to this hall from other areas, such as the horticulture room. As a consequence, several pairs of wing-backed easy chairs were moved into the location to join the two originally placed there. Subsequent studies have shown this has remained the most popular seating area in MPN (Milke, Beck, Ledewitz, 1999). The popularity of the area could be explained by several factors. Not only do the East windows allow residents to bask in morning sunlight, which may have provided some heat as well as light,

for many months of the spring, summer and fall, this seating area provided the best view for street and sidewalk activities. At a distance of approximately one block, children can sometimes be seen in the schoolyard. The view included the centre's front parking lot, the approach to the centre's main exterior door for visitors, and a view (at an angle) down the avenue on which the centre was situated. The angle of the street view meant that vehicles were in view for a longer period of time, which perhaps was helpful to persons with dementia. In comparison, the front street hall in this centre (at right angles to the Green area hall), presented a view of the parking lot, the centre's main door, at an extreme angle, and a straight-on view of the avenue (the ambient light was 527 lux, Table 2, and lighting at the chairs ranged from 418 to 440 lux, Table 5). It was the second most popular seating area in the common area of the centre.

An unpopular area, according to past observations, was the back patio hall. The afternoon sun shone through another window wall, and bistro tables were placed there with chairs for small group interactions. Part of the hall was just outside the beauty salon, and when the beautician was working some residents would sit there to watch. There was no awning to reduce the light, but these windows, like all windows in the common area, had Mecco Shade mesh blinds adjusted through side pull-chains to help control the light. The high reading of 32 500 lux found in this study for the bistro tables gives some indication of why staff said residents avoided these tables for much of the day. Residents have said they dislike sitting in the bright sunlight here because of the heat; however, the L-shape of the building meant they only had direct sun during the mid-day hours.

A number of window combinations were used in the construction of MPN. One notable example was in the great room, the major gathering space for exercise groups and large social events. Clerestory windows were used on both sides of the room to admit light to the centre of the building. However, these windows received a number of negative comments from staff because the sun's angle at some times resulted in blinding light along one wall, and at other times the room was too dark (Milke 1997). The courtyard doors in the living-dining rooms, bedroom halls, and common areas hall had full glass panels to admit natural light. Window walls were a feature in three lengths of hall in the common areas.

Dutch or half-doors were used on all bedrooms at MPN, and light sources in bedroom halls were minimal because it was expected that the top half of the doors would be open and provide the hall with natural light entering through the bedroom windows. In practice, it was found that staff did not like the half-doors and kept them locked together. Moreover, staff sometimes encouraged the closing of bedroom doors when they had a resident who rummaged through other peoples bedrooms. Low nighttime lighting was preferred to encourage residents who rose at night to come toward the brighter kitchens where staff were located. Some lights were on 24 hours a day (Appendix E) in the bedroom halls and other halls to ensure residents had some light wherever they went.

French doors were used extensively throughout the common areas of the centre, a design feature that allowed light to pass into many of the small special purpose rooms in the common areas. This meant that there were many reflective surfaces. The great room at two entrances, the horticulture room, the music room, and the entertainment room, have double French doors. The family dining room and the beauty salon have a single French door with two matching glazed

side panels each the size of a single door. All of these were made to appear as if brass mullions separated small square panes of glass. The advantage of using French doors in these common areas was that supplemental light could be admitted from either the front street or back patio halls. There have been no reports of residents' negative reactions to reflections related to the mullioned French doors. The only mirrors found at MPN however, are in bathrooms. They are not used as a decorative feature, because persons with Alzheimer's disease are frequently reported to have negative responses to reflections (Alzheimer's Care Guide 1999). One MPN resident, during a late-middle phase of her Alzheimer's disease, reacted negatively to all mirrors and the clear glass panel in the courtyard door located in the bedroom hall. The only other negative response to a reflection by a resident was observed on the back patio. The dark interior of MPN turned the window wall into a mirror in bright sunlight and the resident commented on "the scarecrows" she saw, which were actually dark reflections of a number of residents on the patio.

Building and Orientation Features - McConnell Place West

The second centre, MPW, was constructed in 1998 on an east-west orientation, with the main door facing east. The front exterior features appeared similar to those at MPN. The total square footage for the facility was 23 864. Of this, 1629 sq. ft. was allocated for administration, with the remainder dedicated to resident use. As in MPN, there were three residential wings, referred to as houses, linked by a shared common area. The colour-coding theme was repeated in this centre to help with wayfinding (Blue, Rose and Green, Figure 2). Each house was self-contained, with a kitchen, living-dining room, laundry, and tubroom. There were 10 private and one semi-private bedrooms per house, for a total of 36 beds for the centre. As with MPN, each bedroom had an ensuite bathroom attached. The "wandering pathways" are an important part of the design, as they were at MPN. All exterior doors from the residents' portion of the centre led to patios and courtyard areas in the secured yard, and all areas were linked by cement paths that led back to the doors.

MPW incorporated several internal design changes. As mentioned above, the post occupancy evaluation of MPN revealed that the kitchens and living-dining rooms in all houses were heavily used. The craft, music, and horticulture rooms were not well used (Milke, 1997). Design professionals decided to omit these rooms in the plans for MPW, assign the music and horticulture activities to other areas, and use the available space to develop larger kitchens, larger living-dining rooms, and wider bedroom halls in the houses. As a result, MPW was designed to have only 11 special purpose areas. In addition, space assigned to the centrally located craft room at MPN was assigned a new purpose at MPW, becoming the office and supply room for the activity convenor. However, a storage area at MPW was converted into a workshop for one resident's hobby. In fact, none of the activities for which the special purpose rooms were named at MPN were relinquished at MPW. The organ and piano were located in the great room, and a place for indoor gardening, with a potting sink, was added near a patio door to one outdoor courtyard.

Another design change involved admitting natural light into the great room. As mentioned above, the clerestory window design used at MPN caused problems with the sun's angle at various times of the day. At MPW, the clerestory windows were replaced with skylight window

units. A specially designed reflector was also installed near the center of the ceiling to admit and diffuse sunlight through a specially designed strategy to bounce light through the room.

A window was installed in the west-facing Blue laundry room, but not in the other laundry rooms. In addition, the doors to all MPW laundry rooms had windows installed to encourage resident involvement in chores.

A number of changes were made to the administration area, not considered in this study because the focus was on resident areas. Additional space, totaling 39 sq. ft. in all, was added to improve staff work space in the medication rooms in each house. This was another staff area not examined in this study.

As with MPN, a U-shaped driveway gave access from the street, and a staff parking lot was located to the north of the building. An acute care hospital, a care housing, and a continuing care centre were located in the same city block.

MPW had no buildings that shaded its windows or any part of the gardens. Although there were no trees providing direct shade to the building at the time of the study, the landscaping was more mature than MPN, because design professionals were able to plan construction around a large number of older trees on the land. Around the back patio area and cement sidewalk, there were 30" tall path lights were situated to facilitate early evening walks.

The morning sun entered through an east-facing window in the front street hall. Easy chairs located in this area had light meter readings ranging from 326-361 lux. Ambient light was 537-921 lux. Residents had a view of a street that provides access to the nearby continuing care centre, as well as a small strip mall and an apartment complex.

One major difference between the sites was the fencing. While MPN had a chain-link fence surrounding the site, MPW had a stained board fence. This restricted residents' ability to see people walking by, but provided more protection from a busier avenue located directly south of the building that led to the acute care hospital and a major mall beyond it.

Again as with MPN, French doors were incorporated throughout the centre to provide a residential look. Double French doors were found at two entrances to the great room and on the entrances to the entertainment room and family dining room. The family dining room had double French doors into the great room, and at the entrance to the front street hall a single French door and two matching glazed side panels each the size of a single door. Single French doors were used at the entry for the beauty salon, activity convenor's office, and the family dining room. Beside the French door, the former two rooms had a matching glazed side panel the size of a single door.

APPENDIX H

PROCEDURES FOR OBTAINING FUNCTIONAL AND GRID METER READINGS FOR COMMON ROOMS AND SHARED SPACES FOR McCONNELL PLACE NORTH AND McCONNELL PLACE WEST

The procedures for obtaining functional and grid meter readings for common rooms and shared spaces for McConnell Place North and McConnell Place West are included below. The requested meter readings outlined here were the basic minimum requirement for the study. As circumstances permitted, such as the presence of resident activities, or as the room size demanded, the measurement team was encouraged to take additional readings. They were to concentrate on higher-use areas within rooms and to maintain a grid pattern that did not over-sample areas next to windows. The focus of the study was to determine what levels of lighting the residents had available for their activities.

INSTRUCTIONS AND LOCATIONS FOR LIGHT METER READINGS

The technician and the researcher are to focus on obtaining light meter readings that will provide minimums, maximums, and medians for each area. They should take an equal number of readings under light sources and in between light sources. If light sources are in rows beside a window and away from a window, they should do equal numbers under light sources and in between light sources near the window and away from the window. Where applicable, blinds should be up during the day, and pulled down at night. When a measurement is done in a room or area, all lights should be fully on; that is, they should be set to emit the maximum illumination possible. All fluorescent lights must be switched on at least one hour before measurements are taken. All room doors should be shut during measurements within the room.

The technician and the researcher should look for the darkest possible area to take measurements within a room. They should also look for the lightest probable area, considering windows and light fixtures, and take measurements there.

Common Areas

Beauty Salon

Functional	Take a meter reading at face height at the mirror. Take a meter reading at sitting height at both the dryers and sinks.
Grid	Take a meter reading directly under fluorescent lights, and then in darkest corner.

Craft Room

Functional	Take meter readings at the sink, on the table, and at even spaces along the counters.

Grid	Take a meter reading directly under the fluorescent light. Take a meter reading at the darkest corner of the room.
Entertainment Room	
Functional	Take meter readings at chair height.
Grid	Take meter readings at face height in 3 evenly spaced locations in the room. Take a meter reading directly under 2 light sources, and then 2 in between the light sources.
Family Dining Room	
Functional	Take meter readings at table height in the table centre and at either end of the table, as well as at face height . Take 3 evenly spaced meter readings on the counter. Take a meter reading in the middle of the stove.
Great Room	
Functional	Take meter readings at the piano music rest, and at a number of chairs (3 chairs spaced evenly on each side).
Grid	Take a meter reading under the central hanging light and under 2 downlights at each side of the room, and 2 meter readings at the side in between these light sources. Take these meter readings at both floor and face height. Take a meter reading in the darkest part of the room.
Halls	
Functional	Take a meter reading at chair arm height on any chairs.
Grid	Take a meter reading at face and floor height. Meter readings should be taken directly underneath 3 sources of light, and then 3 in between these sources. Take a meter reading from the darkest part of each corridor at face height (approximately 5 ft).

Horticulture Room/Area

Functional	Take evenly spaced meter readings on the counters. Take meter readings on either end of the shuffleboard table. Take meter readings at chair armrest height for 3 chairs.
Grid	Take meter reading directly under 2 light sources, and then 2 in between.

Library Seating

Functional	Take meter readings at shelf height, chair arm height, and coffee table heights.
Grid	Take meter readings under 2 of the main light fixtures (at MPN this may be a chandelier and downlight), and then again 2 in between each of these.

Music Room

Functional	Take meter readings on the couch and chairs at armrest height. Take a meter reading at the organ music rest and at the coffee table.
Grid	Take a meter reading at face height in the middle of the room. Take a meter reading directly under 2 light sources, and then 2 in between them.

Outdoors

Functional	Take a meter reading midway at front bank of windows (face height). Take a meter reading midway at back bank of windows (face height and both on horizontal and vertical planes).

Shared Spaces

Living-Dining Rooms

Functional	Take a meter reading at each table at table height. Take a meter reading at face height in the middle of each room entry. Take a meter reading at each of the chairs at armrest height in the living room areas.
Grid	Take a meter reading directly under 2 light sources, and 2 in between them.

Kitchens

Functional	Take a meter reading at face height in the middle of the kitchen. Take meter readings at the counters, one on each side of the sink, and 2 at either end of the small counter (for MPW, at either end of the island). Take a meter reading at the sink. Take a floor meter reading in the middle of the kitchen.
Grid	Take a meter reading directly under the light source. Find the darkest corner of the room and take a meter reading there.

Laundry Rooms

Functional	Take meter readings on each of the counters and at sink. Take meter readings on both the washer and dryer.
Grid	Take floor and face height meter readings in the middle of the room.

Resident Bathroom

Functional	Take meter readings at sink height, at mirror (face height and on a vertical plane), on the toilet, and with the main light out (should have night light on).

Resident Bedroom

Functional	Take meter readings at bed height, and at chair height at armrest height.
Grid	Take meter reading under central light. Find the darkest corner of the room and take a meter reading.

Tubrooms

Functional	Take a meter reading at sink height, mirror height (on a vertical plane, on the toilet, and at tub height.

APPENDIX I

STAFF AND FAMILY SURVEY

The following is a copy of the survey sent to staff members and family members to ascertain their opinions of the lighting levels within the two centres and some demographic data.

Lighting in McConnell Place North and McConnell Place West

Earlier this year, Canada Mortgage and Housing Corporation granted funding to *The* Capital Care *Group*'s Research Office to begin a study which will look at the standards of lighting within our two residential-style Alzheimer's care centres. We're conducting the study to determine how effective the lighting levels are in both McConnell Place North and McConnell Place West. There is very little field research with elderly people to see whether lighting standards that are set by the industry are appropriate. We do not know what is adequate for residential care settings. This is especially true for special populations like persons with Alzheimer's disease, who may have different needs because of unique visual problems.

Part of the study includes the attached survey, which we hope you will complete. Its to find out the opinions of staff and family members on the lighting levels within each centre. We'd appreciate it if you could fill the questionnaire out and return it to us in the enclosed self-addressed stamped envelope.

All answers will be combined for each centre, and no individual survey results will ever appear in a report. The completed surveys and reports will be kept in a locked drawer by the study coordinators. If you have questions about anything related to the study, please ask the manager of your site, or phone Dr. Doris Milke, Research Coordinator (numbers are below).

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ACTIVITIES

We've put together a list of activities that happen at both McConnell Place North and West. Please let us know which ones you participate in while at the centres, as well as your opinion of the lighting levels ***from the residents' perspective*** in the areas you do these activities.

Activity	Where do you do this?	What time of day do you do this?				How long do you do this for?		Do you think the lighting is adequate in this area?	
Arts & Crafts		8-11	11-1	1-4	4-8	hr	min	Yes	No
Table Games		8-11	11-1	1-4	4-8	hr	min	Yes	No
Chores		8-11	11-1	1-4	4-8	hr	min	Yes	No
Clerical Tasks (Writing)		8-11	11-1	1-4	4-8	hr	min	Yes	No
Cooking & Baking		8-11	11-1	1-4	4-8	hr	min	Yes	No
Dancing		8-11	11-1	1-4	4-8	hr	min	Yes	No
Eating		8-11	11-1	1-4	4-8	hr	min	Yes	No
Exercise		8-11	11-1	1-4	4-8	hr	min	Yes	No
Grooming		8-11	11-1	1-4	4-8	hr	min	Yes	No
Group Activities		8-11	11-1	1-4	4-8	hr	min	Yes	No
Medical Treatments		8-11	11-1	1-4	4-8	hr	min	Yes	No
Music		8-11	11-1	1-4	4-8	hr	min	Yes	No
Playing Cards		8-11	11-1	1-4	4-8	hr	min	Yes	No
Reading		8-11	11-1	1-4	4-8	hr	min	Yes	No
Walks		8-11	11-1	1-4	4-8	hr	min	Yes	No
Woodworking		8-11	11-1	1-4	4-8	hr	min	Yes	No

PLEASE COMPLETE THE NEXT PAGE

RESPONDENT INFORMATION

Your name isn't required, but it would be helpful to know a few things about you. Please answer the following questions.

1. My relationship to the residents at McConnell Place North or West is (please circle one):

   Family Member Staff Member

2. Gender (circle one): Male Female

3. I require glasses to read: Yes No

4. I require glasses to drive: Yes No

5. I have the following vision problems (please circle all conditions that apply):

Limited Night Vision	Yes	No
Glaucoma	Yes	No
Cataracts	Yes	No
Legally Blind	Yes	No
Other	_____	

6. My uncorrected vision rating is: _____/_____

7. My correction vision rating is: _____/_____

8. Normally eyesight will change at several times during our lives, so it is very important to know what age group you're in.

   My age is (please circle one):

   Under 40 Between 40-50 Between 50-70 Over age 70

APPENDIX J

INSTRUCTIONS TO OBSERVERS AND CODING SCHEMA USED FOR DIRECT REAL TIME OBSERVATIONS

Two observers are to:

- Ensure that each manager has fully informed the staff and the Family Council about the observations being done.
- Be familiar with the centre and able to distinguish residents and staff members from visitors and occasional workers who may be in the centre from time to time.
- Accurately associate all of the rooms in the centre with the same room on the floorplan sketches that are a component of the data collection forms.
- Memorize the definitions for the activities defined in the coding scheme below.
- Spend sufficient time practising together, on-site, until errors in judgement, as indicated by interobserver reliability statistics, are less than 5%. Errorless scans are those in which the two observers have perfect agreement about what they have seen, including the classification of people, their location within the centre, and their activity.
- Spend two days collecting hourly data, following the guidelines below, from 8:00 a.m. to 9:00 p.m. at each centre.
- Work together for 20% of the scans each day to determine the interobserver reliability between observers, following the guidelines below for interobserver scans.

Directions

I. **Code the presence of each person observed by writing the alpha-numeric codes described in the sections below (II, III, IV) on the floorplan-map at the location where the person is seen.** The space where the observer writes on the paper will be assumed to identify the particular part of a room where a person was seen, and that room will be entered into a computer file as the location.
Scan all public areas that are accessible to residents within the care setting on each hourly tour through the building. Do <u>not</u> to go into private bedrooms, or any bathroom. Observations should not interfere and should not intrude on the care provided an individual resident. Locations not usually accessible to residents are not scanned.

II. **Code all persons observed as one of the following four classifications.** The individual identities of persons are not recorded.

1. Residents – use **R** on the floorplan sketches. These are *regular* residents
2. Staff – use **S** on the floorplan sketches. These are persons involved in *regular* care. Typically, they are persons counted in the staffing pattern; however, the activities coordinator, who spends many hours a day with residents should be counted as regular staff.
3. Family – use **F** on the floorplan sketches. They are often seen interacting with residents and behave like personal visitors.

4. Other Persons – use **P** on the floorplan sketches. They may be performing direct services for residents; for example, hired companions, physicians, podiatrists and the beautician. Include volunteers who are helping these persons here. Include pastors and priests here. Include staff of the organization, such as the manager of the centre, who appear irregularly, or workmen, such as plumbers or electricians here.

Include all persons seen, but count each individual only once per scan, even if that person moves from room to room. Do not indicate the names, initials or any identifying information for individuals anywhere on the data collection form.

Table I-1
Activity Coding Scheme for Observing Resident Activity at McConnell Place North and McConnell Place West
Defined to be mutually exclusive and comprehensive

Predominant Activity		Short Definition	Sub-category of the predominant activity
2	**Just sitting**	The person is inactive and not engaged in an activity, such as a meal or some leisure pastime, and not engaged in watching such activities, then this code is used. Often the person may appear to be unresponsive to what is occurring around them; the eyes may be glazed over, but typically the person is in a position normally referred to as 'seated', although on rare occasions a person may be standing and unresponsive.	
3	**Activities of Daily Living (ADL)**	Day-to-day acts involved in a person's self-care, such as eating, receiving medications, grooming, washing oneself, etc. *This code is selected whether or not a person is, concurrently, walking, sitting or standing.*	
31	"	Eating	Ingesting food or drink.
32	"	Grooming	Washing oneself, or brushing one's hair etc.
33	"	Medical treatment	Receiving medications, or *dressings*, etc.
4	**Working**	Tasks considered labour, including preparing food for oneself or cooking, housekeeping, doing laundry, adjusting blinds, and yard-related work. *This code is selected whether or not a person is, concurrently, walking, sitting or standing..*	
41	"	Chores	A small or routine task, or the everyday work around a house or yard. Include adjusting blinds and setting tables.
42	"	Clerical tasks	Writing, typing, keeping records, filing, or performing other general office tasks. Also delivering mail.
43	"	Cooking & Baking	To prepare food for oneself or others.

5	**Leisure**	Recreational activities include planned and informal activities; for example, attending teas, participating in games and exercise groups, listening to the radio, watching TV, and looking at books. Include persons not actively engaged in recreation, but attending it and remaining within range so that they could participate. *This code is selected whether or not a person is, concurrently, walking, sitting or standing.*	
51	"	Reading	To look at so as to understand the meaning of something written, printed, etc., including reading music.
52	"	Music Event	To be present at, or waiting for the beginning of, a musical performance.
53	"	Arts & Crafts	Participating in, or waiting for the start of, a past-time that requires manual skill.
54	"	Games	Participating in, or waiting for the start of a competitive activity involving skill or chance, and played according to a set of rules for the amusement of the players or spectators.
55	"	Dancing	To move one's feet or body, or both, rhythmically in a pattern of steps to the accompaniment of music, or to await the opportunity to engage in such activity.
56	"	Exercising	Participating, or waiting for instructions, in some bodily exertion done especially for the sake of training or improvement.
57	"	Small Group Activities	Participating in person-to-person(s) interaction or communication. All forms of communication, not just talking, are included; for example, gesturing, listening to someone talking, or holding the arm or hand of someone. Include the conversation at a small table, such as that occurring after a meal, or around a coffee table.
58	"	Large Group Activities	Participating in, or waiting for the start of functions other than those listed above that involve some synchrony, or simultaneous occurrence, between a number of people. Include church services and afternoon teas involving many people. *This code is selected whether or not a person is, concurrently, walking, sitting or standing.*
59	"	Playing Cards	Participating in, or waiting for the start of a game involving a "deck of cards" with spots, figures, etc.
510	"	Woodworking	The act or art of working with wood.

511	"	TV	Watching the broadcast of a still or moving image on a picture tube, or the projecting of such images on a "movie screen."
512	"	Performing music	Playing a musical instrument to entertain others or themselves.
6	**Disturbing Behaviour**	A behaviour that is disruptive to other persons. It should not be merely an aberrant behaviour, such acting as if a hallucination is seen. For a disruptive resident behaviour, an observer would anticipate a staff intervention, as in the example of one resident hitting another.	
7	**Walking**	To advance or travel on foot at a moderate speed or pace, or to propel one's wheelchair to obtain the same effect. This code is used unless the movement is observably part of a work activity or a leisure activity. It is not used when there is a concurrent work, leisure activity, ADL, or communication.	
8	**Watching**	Attending to activities, or intently watching the interaction of other persons from a distance, such as observing recreation from a doorway. An example is looking out a window and attending to the view of the front driveway and street.	
9	**Other**	Miscellaneous activities, such as sleeping, but not an *ADL,* or *leisure* activity, and not *sitting* or any other coded activity.	